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MADRAS FISHERIES BUREAU.

ANNUAL REPORTS

OF THE

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1908—1917.

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MADRAS FISHERIES BUREAU.

BULLETIN No. X

BEING

PART II OF BULLETIN No. I.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., Honorary Director, Madras Fisheries.
Dated—the 29th March 1909.

I have the honour to submit a brief report of work done in the Fisheries office from January 1908 to the end of March 1909

I remained in charge throughout the period ; Mr. H. C. Wilson, appointed from 1907 as Piscicultural Expert, was also on continuous duty ; in July Mr. James Hornell, F.L.S., came in as Marine Assistant on an engagement for one year, and Mr. V. Govindan, B.A., was appointed Personal and General Assistant. A small staff (two) has been appointed to the Ennore Experimental Station, where a West Coast Volunteer, without pay, has joined at his own request, to study our methods.

Ennore Experimental Station.—The first important work was the planning of an experimental Marine Station for economic work as suggested in paragraphs 186 to 194 of my Note on Japanese Fisheries and in paragraph 16 of my letter No. 230 of 31st December 1907. This was drawn up at length in my No. 55, dated 5th May 1908, and was sanctioned in G.O. No. 1635, Revenue, dated 12th June 1908, the location selected being Ennore for reasons given. The building and compound—the Public Works Rest House—were handed over on the 5th July 1908 and I appointed a Superintendent and Head Curer. The objects were the establishment of improved catching methods by large boats and more powerful nets, etc., and the production of absolutely sound and wholesome food, firstly, by keeping fish alive

up to shore in live-wells, chests, or cars, secondly, by properly treating dead fish (*a*) on the boat, (*b*) on the way to market, (*c*) in the curing factory, proper curing, viz., by perfect cleanliness, rapidity, thoroughness, and by novel methods such as smoking, pickling, etc., being especially aimed at.

Little could be done to the end of 1908 beyond repairs and the starting of salting and smoking arrangements, since everything was novel and the place of course a blank ; also the north-east monsoon and the two months' tour with the "Margarita" on the West Coast intervened. Advance has, however, been made in various directions.

A beginning has been made in investigating the proper treatment of fresh (not cured) fish on the way to market or to the consumer, so as to ensure (1) that it shall arrive at its present market, especially inland, in good condition, (2) that the markets or areas served shall be considerably extended. This is perhaps the most difficult of problems in a country possessing a fully tropical climate ranging roughly from 70° F. to 100° F. with slight variations on either side, and yet poor both in the material assets which simplify the question in the West, such as wealth and high prices, cheap ice and coal, short journeys and rapid transport, and also in the possession of moral assets such as business enterprise, technical knowledge, educated public tastes and opinions, sanitary regulations, and so forth. The problem is how to get wholesome, untainted, fresh fish to market, even in Madras but more particularly inland, without ice as a rule, at low cost, and in large quantity.

As regards sea-coast markets it is merely a question (*a*) of keeping the fish alive to shore, (*b*) of cleaning and treating dead fish at sea ; this has been adverted to above as waiting the large boat and live-car. As regards inland markets it is the above *plus* further conditions. In the matter of refrigeration it means better packing and better arrangements on the railway ; without refrigeration it means thorough cleanliness and careful packing, and, for distant markets, the slight use of simple, innocuous preservatives. The investigation of this problem has just begun at Ennore ; thoroughly cleaned fish are being packed in various ways and kept in a closed chest as they ought to be in a railway van, and compared with others

packed in the way now usual; experiments are, however, insufficiently advanced for record and await the coming hot weather.

It has, however, been proved by numerous experiments that fish, well cleaned and soaked for a few minutes in weak brine with a slight admixture of a boric preservative will keep *perfectly* up to at least 24 hours *without the use of ice* even in March, especially if wrapped in special paper; Solling's paper has been tried but vegetable parchment has proved better, and ordinary "butter paper" was practically as good as the latter and much cheaper. The boric preservatives (Keeps and Arcticanus) are absolutely innocuous even when taken into the system in considerable doses; the recent British Departmental Committee on Preservatives expressly suggest 0·5 per cent of boric acid as permissible even in such foods, e.g., butter, potted meats, etc., as are taken bodily into the system, whereas in the case of fish less than this percentage is used and then only as a mere detergent and antiseptic bath, little of which penetrates the tissues and the whole of which is extracted in the usual course of soaking and cooking. If, as shown, the use of these harmless preservatives, even in such minute quantities, entirely prevents taint for 24 hours, then the up-country consumer can obtain fresh fish at cheap rates at all events for much of the year, and above all, free from the deadly ptomaines and toxins of incipient decomposition, a stage in which much of the "fresh" fish at present arrives a few miles from the coast. Even when sent in ice the fish is frequently uneatable—experto crede—and a slight antiseptic wash will greatly improve its travelling powers. The precise details and methods are being separately reported, but I may say that in some cases in March, fish caught during the day were treated at 4 P.M., packed in simple parcel papers, taken without ice by rail throughout the night, and eaten, e.g., at Yercaud, absolutely fresh and good, at noon next, and were also good on the following day, if cooked soon after arrival. In the curing yard they were kept for more than 24 hours without the slightest sign of taint appearing.

The "Hislaire" process of preserving fish by "Sterilisation" has also been tried, probably for the first time in India. This was well spoken of in 1907 when I was in England and I then obtained useful results,

as mentioned in my No. 55 of 1908, and in my Pamphlet on Fish Preservation; the Ceylon and Indian Newspapers also recently discussed it. As I had bought a steriliser and pastilles I have been experimenting it at Ennore with remarkable results; the fresh fish treated have been hung in the open air and have continued without taint up to complete dryness though they have received *no salt, ice, or preservative whatsoever;* flies entirely abstain from touching them; when wrapped in "butter paper" or other good quality of air proof paper, such as vegetable parchment, the fish kept perfectly good for days. The fish are quite indistinguishable from untreated fish in appearance, taste, or digestibility and can be—have been—sent up-country without ice and without fear of taint *en route;* this has been proved by actual experiment in March. The experiments are now proceeding and will continue through the hot weather and I am of opinion that the process will be found successful; the sterilised fish has been subsequently smoked with much success.

The chlorine process, viz., that of steeping fish in electrolysed sea water, is also under successful experiments; by the courtesy of Messrs. Binny & Co., I am being supplied gratis with the fluid, the preserving power of which *per se* so long as chlorine is evolved, has been completely demonstrated; it has also been proved that the smell of chlorine is evanescent and entirely disappears in curing, though in fresh fish a slight smell occasionally remains. If completely successful the process will be very váluable, since *absolutely nothing* is added to the fish which can be brought from sea to shore in a weak bath of the solution in a *perfectly fresh* state, and can then be treated as desired. In curing the process enables us to use light salting by keeping the fish good while the fish is in this light pickle and until it can be taken out, dried, and smoked; such fish must, however, be consumed at an early date. The process will probably be applicable not only as above but in transporting fresh fish inland, since experiment has shown that fish even when cooked and eaten fresh, practically loses the smell of chlorine. The fluid used for electrolysis is a solution of our ordinary sea salt in water. This and the Hislaire process, and the preservative effect of a slight addition to the

salt of a boric preservative, are important demonstrations, but the experiments will be continued throughout the hot weather for further testing.

In the matter of *curing* fish advances have been made by observing absolute cleanliness especially in the gutting shed and in the thorough washing of the fish; plain salted fish are obtained without the least degree of taint, and which only require more manipulative skill to become a product that would be considered first-class in foreign markets. The discoloured salt which alone is procurable is one stumbling block, and I am compelled to dissolve, decant, and evaporate if I wish for fairly white salt; from one yard the yellow mud obtained amounted to 10 per cent of the salt dissolved. The amount of salt required, the period in salt, and the best method of drying are all matters under investigation, as also the method of salting by immersion in strong brine instead of the method of dry salting. Proper scaffolds and "flakes" for drying are of course in use and are very efficacious and cleanly, as compared with the indigenous method of laying on mats on the ground. Very few blow-flies attack properly treated fish and even these can be and are being entirely kept away either by using gauze coverings over the flakes or by a sprinkling of preservative; naturally I favour the former.

Most of the salted fish has received an additional antiseptic treatment by being *smoked*; the kilns in use are simple and cheap, the cost of fuel is negligible in a kilnfull of fish, and the product has found general acceptance and favour. Mackerel, ribbon fish (Trichiurus), Seriolichthys vipinnulatus (a horse mackerel), small seer, large seer in slices, pomfret, and kora (Sciaena), have been the chief fish smoked, and have all been successful; there is already a considerable demand and it is now within any one's power to take up the process as an industrial business and to fill the demand. The British and Indian soldiers are strongly in favour of the products which supply a tasty and appetising food, and high Madras households have by no means disdained the locally-produced substitute for the kipper, the bloater, and the haddock; to consumers up-country this substitute for the almost unattainable fresh fish, for the expensive tinned goods, or for the indigenous product,

has already proved acceptable and will be still more so as the processes develop in the direction of a more lightly cured article. I may add that actual demonstrations with kilns and fish and lasting about a fortnight each, were given on the West Coast (Cannanore and Tellicherry) and at Waltair; at Cannanore the British troops and the Jail have taken up the manufacture, and various Companies and persons have followed suit, especially one Company to whose Principal I showed my first smoked fish (mackerel) in October and whose agents have since inspected the Cannanore and Ennore smoking places. Demands have reached me from Bombay, the United Provinces, the Punjab, etc., and I am now trying to increase my output so as to increase the knowledge of, and demand for, the product and thus prove to private capital that there is a demand which is not only already great but may easily develop up-country to an enormous business. I shall, of course, be only too ready to give up the business if private capital will take it up, as the work of the station is purely experimental, demonstrational, and educational. Experiments are proceeding in the way of providing lightly salted and smoked goods for early consumption, the present goods are intended to keep for some time.

As sanctioned by G.O. Mis. No. 2980, Revenue, dated 26th October 1908, a small area, perhaps half an acre, of the backwater alongside of the station sheds has been enclosed by post and wire, and a very successful first attempt has been made to ascertain the period, cause, duration, and abundance of the fall of oyster spat, to receive it on "collectors," and to ascertain the rate of growth, which, in other countries, would be considered phenomenal; the best grown young oyster was 5 inches in breadth at less than 2 months old. This gives an idea of the possibilities of oyster culture in our warm and shallow backwaters, and, as already suggested *passim* (e.g., paras. 42 and 65 of my No. 55 of 1908), of supplying countries such as China with their dried flesh, or other countries with oyster extract as prepared in the United States; this latter product is most nutritious and digestible, and can be put up in tins, jars, etc., and readily exported; in this way the valuable constituents of hundreds of millions of oysters could be secured as food and a large industry started.

The matter has been reported on in Mr. Hornell's reports sent with my covering letter No. 115, dated 5th March 1909, and the experiment will be developed next autumn when a spat-fall is due.

In G.O. No. 2267, Revenue, dated 17th August 1908, Government sanctioned afresh the opening of an Experimental Station on the West Coast in special view of canning and of otherwise treating the abundance of fish there found ; in letter No. 1180B–108–1, dated 26th August 1908, they approved of my obtaining a *small* oil and fertiliser plant such as would be suitable for very small capitalists or even fisher folk, as a demonstration of what might be done in every coastal village to provide *good* fish oil and good fish guano free from oil from the fresh or dried sardine, a subject on which I wrote newspaper articles which have excited interest. This station has not yet been started as I hope to examine suitable plant in England. Meanwhile I was interviewed on the West Coast by several persons—one a large Mangalore firm—on the oil and fertiliser business, and inspected a small wooden press erected by Mr. M. C. Choyi of Cannanore on the direct suggestion of my Personal Assistant, Mr. V. Govindan, who has long been interested in such matters, and specimens of his oil and fish residue. Mr. Choyi has, I hear, since erected three wooden presses, but is in doubt about a market ; I have advised him to sell his products to one of the local firms who deal in such goods. Mr. Govindan is interesting himself in designing and getting made cheap but effective presses for the purpose, so that any small capitalist can take up the business, and I hope to second his efforts by enquiries at home, as there are numerous effective presses which have passed the test of experience, as well as economical boiling plant.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., Honorary Director, Madras Fisheries.
Dated—Madras, the 21st July 1910.

Submitting report of the work done in the Fishery Department for the year ending 31st March 1910.

* * *

3. *Personnel.*—I remained in charge throughout the period; Mr. H. C. Wilson was also continuously on duty as Piscicultural Expert; Mr. James Hornell who was temporarily appointed for a year in July 1908, came in from 1st July 1909 on a new contract as Marine Assistant and Superintendent of the Pearl and Chank Fisheries; Mr. V. Govindan, B.A., remained on duty as Personal Assistant, but acted for six months as Superintendent of Pearl and Chank Fisheries during Mr. Hornell's absence on leave in Europe. The staff remained practically as in 1908–1909.

4. The work respectively done by the departmental officers is abstracted as follows, it being premised that merely salient items are mentioned and those only in outline; the bulk of the work cannot be put on paper in a department dealing mainly with investigation and experiment. During the year Mr. Wilson completed arrangements at Avalanche for the rearing of trout, obtained through Government an excellent consignment of *irideus* trout ova from New Zealand, very successfully hatched out the eggs and stocked all suitable streams on the Nilgiris with fry, besides stocking the Avalanche and Emerald Valley rivers with mature trout; he also continued his supervision of the upper waters of the Bhavāni and Moyār rivers. He inspected the larger tanks of the Periyár system and the Periyár Lake in view to fish culture; also the larger tanks (Barúr, etc.) of the Salem district, and the great tanks of Daroji and Cumbum with a similar view; the reports embodying his proposals have been laid before Government. He completed a scheme for the annual propagation of hilsa in the Coleroon which was sanctioned by Government and put into execution, and the possibilities of transferring hilsa to the West Coast were also experimentally examined. The upper reaches of the Cauvery were examined, and especially the Hoginkal area where an annual and very destructive fish drive is said to take

place with the use of dynamite and other illegal methods. A most important experiment was devised in all details and sanctioned by Government, viz., the Sunkesula fish farm at the anicut of the Kurnool-Cuddapah Canal, in view to stock the 200 miles of this canal with good fish ; work will be begun this year.

Mr. Hornell took charge from the 1st April 1909 of the Pearl and Chank Fisheries transferred to this department by G.O. Press No. 601, Revenue, dated 4th March 1909, and completed his inspection, in company with the Port Officer who was till then in charge, of the Pearl Banks ; he also examined questions such as the supply of sea weed for industrial purposes, a point raised by a large Madras firm. In May he obtained leave on medical certificate and proceeded to Europe where, however, at my request, he devoted rather more than half his time to various important investigations, viz., the best class of motor-engine for Indian fishery work, the best designs compatible with cheapness for an inspection schooner, the great Arcachon oyster fish culture and sardine industries, certain methods of fish curing in Scotland and Cornwall, the celebrated fish culture systems of the Comacchio lagoons, etc. On these enquiries he visited Scotland, Ireland, France, and Italy, his journeys including short voyages on fishing boats and the Irish Scientific Cruiser " Helga," and he got into touch with the several Fishery departments and their officials. On returning to India in October, he inspected as per G.O. Mis. No. 2822, Revenue, dated 14th October 1909, the oyster beds near Karachi on behalf of the Bombay Government and reported on the same. From November he was in charge of the Pearl and Chank Fisheries as mentioned below and in the regular report, and has sent in reports on most of the matters examined in Europe, together with proposals for oyster culture based partly on his enquiry at Arcachon and partly on results obtained in oyster growth at the Ennore Experimental station. He has also, as Marine Assistant, supervised the building at Tuticorin of the motor fishing boat " Turbinella." negotiated the sale of the " Margarita," etc.

Mr. V. Govindan, Personal Assistant, was in charge of the Pearl and Chank Fisheries branch during Mr. Hornell's absence in Europe, carried chank operations

to a successful close in July, and initiated work in September and October for the season just expired, besides keeping me in touch with all current work during my own absence; he also materially assisted me for several months in starting the Cannanore Experimental station, since which he has begun a very important enquiry into the commercial aspect of fishery work as mentioned below. He continued also throughout to supervise work in general as my Assistant.

Personally I continued my general work as Honorary Director; while at Home I visited Scotland—with Mr. Hornell—and Ireland, partly to acquaint myself with the work done by the several departments, partly further to study methods of fish-curing, especially those of making kippers and Finnon haddocks, and partly to examine the various motor-engines established in actual fishing boats. I settled with Mr. Hornell and certain ship-builders, the design, etc., of the proposed inspection schooner and her engine; I was also approached and interviewed by several persons or firms desirous of starting either fisheries or fishing industries, e.g., fish oil and guano, in India. All important papers were sent to me from India for disposal and orders, and having drawn up a full curriculum for Ennore I was able to supervise operations through fortnightly reports. I examined plant for can-making, canning, and other fishery operations, and purchased small plants for beginning work on these lines. On arrival in Madras in September I continued work at Ennore; but for reasons elsewhere explained, obtained Government sanction to open a large station at Cannanore where, from 20th October to 31st March, I personally carried on continuous work as mentioned below.

The above details have been given as they show, in bare outline, the character of the work done by the department during the year under report.

5. *Marine—Experimental stations, Ennore.*—Paragraph 3 of my report for 1908–09 read in G.O. No. 1215, dated 4th May 1909, mentioned the starting of this station and the objects aimed at, while paragraphs 6 to 18 gave details of work done in the few months of its existence, viz., the keeping of fish fresh on the way to market and consumer, the curing of fish by salting and drying, by smoking, the starting of an experiment

in oyster growth, etc. Work was continued there from 1st April to 20th October but under many unforeseen difficulties, chiefly (1) very poor supply and dearness of fish owing to the proximity of Madras and the inefficiency, etc., of the fishermen ; (2) impossibility of exact experiment owing to the uncertainty as to freshness, or, rather, to the possibility of taint ; (3) inefficiency of labour and want of interest due to the poverty of the local men and absence of any local curing industry. Certain successes in operation required that the experiments should be conducted on a larger or commercial scale ; other experiments were impossible in the absence of cheap and abundant fish, especially shoaling fish such as sardines (for food, oil, guano, etc.) and mackerel. Hence a new station was opened at Cannanore under the sanction of Government contained in G.O. No. 2267, Revenue, dated 17th August 1908 (see also G.O. No. 3488, Revenue, dated 18th December 1909) ; a good site for canning, etc., operations was obtained from the Military authorities but not till February 1910, too late for work ; a small piece of land was, however, leased for general work in November, shedding was put up, and operations carried on for the rest of the year.

6. *Cannanore station.*—This locality is well suited for large experimental work : it has numerous fishermen and abundance of fish, a large fish-curing yard, and a number not only of intelligent curers, but of fish merchants and master curers who cure for Ceylon and other parts, many possessing capital and much business capacity and experience. For about four and a half months numerous experiments were made in catching : in keeping fish untainted without ice (*a*) to shore, (*b*) for one or two days on shore : in ordinary salting and drying ; in smoking, especially of the lighter classes similar to kippers, bloaters, and haddocks ; in the cure of sardines as pilchards ; in the preparation of fish oil and guano from sardines ; in preliminary work on fish paste making. A young man of some means, from Travancore, was also trained in the various operations.

7. *Catching.*—The two sanctioned fishing boats mentioned in paragraph 4 of my last year's report, were both built during the year, one, a sailer on Scotch lines, of about 12 tons, named the "Sutherland"—after the Chairman of the Scottish Board by whose courtesy I

obtained the design—was completed and put in commission at Cannanore in February; as it was then late in the year and alterations and larger nets were required, she did not do much fishing but has already proved herself a useful boat, and has caught considerable hauls of seer and mackerel in 8 fathoms when the inshore boats caught nothing of the sort. The second boat of about 25 tons, built on Arklow designs with a 15 horse-power "Dan" motor and called the "Turbinella" —after the chanks which she will help to fish—was launched during the year, but completed only in the current year; she is a very strong and fine boat, built by the "Madura Co.," Tuticorin, and is much admired.

But the catching work at Cannanore was principally effected during October-December by two Ratnagiri boats engaged for the purpose: these are 6 to 8 ton boats, simple drifters, fishing with their own drift nets, measuring above half a mile when shot, in 8 to 12 fathoms, outside the usual limit of the Malabar canoes; they brought in large quantities of medium seer, small seer (varian), pomfret, Chirocentrus dorab (vālei), small sharks, etc.; 1,500 lb. for one night's work was the largest catch. These boats enabled me to ascertain (1) the character of the fish available in the above zone, (2) the ability of existing boats to catch such fish with existing appliances, (3) the quantities, value, and profits of the catches of such boats, (4) the possibility of keeping fish fresh to shore. The character of the fish (seer, etc.) has been mentioned, and the ability of the Bombay —not Malabar or South Kanara—boats to catch them. The quantities were as follows; in 48 nights of the two months—they did not fish when the moon is near the full —the two boats caught and delivered about 38,000 lb. of fish, by far the larger part being prime; this excludes fish taken by the crews for food and fish rejected as tainted: one boat moreover only fished for 38 nights. Hence each boat caught on an average at the rate of 10 tons for the two months: the value, as paid by a local fish curer and continued by me, was about Rs. 1,600 or Rs. 800 per boat with six men, plus the fish used as food, etc. No hire was paid for the boats, but I agreed to take and they to give their catches at the settled rates which were some 20 to 25 per cent below beach rates.

But it was soon found that the catches were often soft, pasty, or tainted, since the fish, being caught in drift nets, had been slowly suffocated, and had often been dead some 12 hours on arrival at shore; as the crew refused to gut the fish I sent out a gutter on each boat who gutted and washed the fish and applied salt to the cavity; latterly a very small quantity of boric preservative was added to the salt; this precaution *entirely* preserved the fish and I seldom had pasty fish thereafter. The contrast between the fish of the first and last weeks was remarkable. It has, then, been proved that at almost no expense—since, ordinarily, a boat's crew would do the gutting, etc., themselves—a large amount of good fish can be kept good, whereas I have often seen large fish on the beach quite unfit for food even though caught in near waters.

I conclude that Ratnagiri boats are, for *West Coast waters* and weather, well adapted for deep sea fishing all through the fishing season; they are cheap, good sailers, and manage a large fleet of drift nets; those on trial had, however, insufficient room for gutting operations, still less for storing, so that they cannot keep the sea for several days; the larger ones which stay out for a week, should suit better and will subsequently be tried. Until motor boats are introduced these larger Ratnagiri boats should serve our purposes, especially with a motor carrier.

8. *Keeping fish untainted without ice.*—This has been mentioned in the preceding paragraph so far as regards the boats. Keeping fish fresh on shore, e.g., during a journey, is equally possible; the experiments at Ennore during the hot weather and Cannanore more lately, show this. The experiments mentioned in paragraphs 9 and 10 of my previous report were continued, and summing them up I would say that, so far as ascertained, (1) the fish *must* be fresh on arrival at the factory; I cannot sterilise a tainted or even soft fish; (2) they must be gutted, *split*, and washed; I have not succeeded in sterilising or preserving good-sized whole fish *when merely gutted*, except for a short period; splitting is required so as to open out the tissues for the action of the preservative; (3) that a very few, 5 or 10, minutes in strong brine makes sterilisation by the Hislaire process a certain success, whilst a very small

addition (0·5 per cent of the weight of the fish) of a boric preservative to the salt or brine insures preservation for several days ; (4) that one may not count on more than 48 hours' preservation if the fish are packed in a parcel ; longer if the fish are hung up in an airy place ; (5) that the very slight saline flavour noticed when the *brined* fish is tasted raw, disappears on cooking. The 0·5 per cent boric preservative, innocuous in itself, is well within the limit (0·5 per cent of pure boric acid) allowed by the British Departmental Committee for *mixing with butter*, etc., whereas this amount of preservative which, as sold, is a mixture of boric acid, borax, and salt, is merely added as an external application of which the greater part remains in the brine and wholly disappears in cooking. All working details will be given in my new edition of the "Preservation and Curing of Fish". The experiments enable fish under the above conditions to be sent up-country without curing, and in a better and less dangerous condition than if badly packed in insufficient ice. Ice is an excellent preservative if the fish is fresh, if the ice is pure, if it is sufficient, if the fish and ice are properly packed in proper receptacles so that the fish is kept continuously below 32° F. ; *otherwise* I prefer the above safe process for brief preservation. The methods will be more closely studied next season.

9. *Ordinary salting and drying.*—The fish from the Ratnagiri boats and, later, from the "Sutherland" provided material for ordinary curing work. This was successful and the products generally—mere experiments excluded—were found not only commercially acceptable for Ceylon, but realized in several cases, e.g., mackerel, considerably higher prices than ordinary goods ; e.g., I sold 30,000 mackerel at Rs. 4–14–0 per 1,000 when local wholesale prices were only Rs. 4–2–0. Prices, however, are not, at present, fair tests for various reasons ; (1) we do not know the fancies of the particular markets, e.g., Madras does not care for good fish dry-cured and highly salted as for Ceylon ; it desires moister goods of a high flavour, and so on ; Ceylon demands dry goods but they must be split down the back, and have the back-bone cut under and turned over ; if split down the belly, as is required by gutting at sea, they fetch a lower price ; (2) the present salt-fish eating

public is mostly acquainted with goods of a high and even strongly tainted flavour and considers that goods perfectly cured and without a suspicion of taint are "not up to the mark", an expression used in an East Coast market where sardines and mackerel "cured" (!) by simple drying without salt and of the rankest flavour and cheapest price, were alone in demand; we have to seek and to reach that vast and respectable class of the public which at present eats no fish because the ordinary salt fish (karuvad) is unpleasant; these can usually afford slightly higher prices for good goods, and this will gradually effect a change in curing methods and consequently in the goods supplied and accepted. Our fish are rather too good, in the way of absence of taint, for present demands; it is the potential demand of a better class market that such goods must find. Hence the enquiry which my Personal Assistant has begun, as further mentioned below, *s.v.* "Organization."

A parcel of dry salt fish—cod, haddock, ling, etc., was obtained as a specimen from England, and was a revelation to curers in its appearance, flavour, etc. I have experimentally adopted the Western method of splitting the fish by the belly and removing the head and most of the backbone; this greatly improves appearance and decreases weight for transport but is, at present, objected to by purchasers; I have also adopted slow drying under shade, e.g., in a shed, to avoid the discoloration from oil found in all native-cured fish, and have recently obtained considerable success.

10. *Smoking.*—The ordinary and easy method of hard salting and smoking, found quite successful at Ennore, has been more or less discontinued partly from press of other work, partly because private persons had taken it up; it will, however, have to be recommenced and developed. In its place light smoking was begun, a much more delicate operation; the products, similar in character to the bloater, kipper, and haddock of Great Britain, are much more desirable as food, from flavour, digestibility, ease of cooking, etc., than hard-salted goods, but without proper trade organization cannot be put commercially on the market. For fish so treated will only keep good for a few days or up to a fortnight at most, so that unless there is a certain, regular market and fixed demand for the goods, they may easily spoil

on the vendor's hands, while, on the other hand, if he does not keep a good stock he will be unable to meet calls and will disappoint would-be customers. A market like Madras might be easily supplied, but those of provincial towns would be risky unless a set of customers or a regular trade connection has been obtained.

The experiments have been quite successful so far as they have gone but will be carried on next season ; the split fish are either salted or placed in saturated brine for a short period, drained, and smoked ; the product is quite excellent and has delighted customers, to whom the method supplies fish not indeed fresh but only slightly cured. Full details will be published in my manual.

11. *Sardines as pilchards.*—In a letter read in G.O. No. 2267, Revenue, dated 17th August 1908, and elsewhere, e.g., in my book on the "Preservation and Cure of Fish", I mentioned the great wastefulness shown by the improper or defective utilisation of the immense catches of sardine on the West Coast, viz., by drying the fish on the beach and sending them away as very imperfect manure—largely consisting of coagulated oil and sand—to Ceylon, etc., and I proposed to try and utilize them more fully as food. I have since ascertained that the catches are much larger than I thought, perhaps 100,000 tons in an ordinary season between September and April ; a single supplier at a single port supplied last year to a single merchant 600 tons of dried sardine, representing perhaps 1,500 tons of fresh fish, to be sent as manure to coffee estates. This manure, as prepared by the common fisherman, is generally of the poorest quality, frequently so devoured by maggots, weevils, etc., that little but scales and bone are left ; the smell of the beaches shows how much nitrogen is wasted. Only a fraction of the fish is turned into food, and much of this is simply dried *without salt* and sent away in tainted masses as food to our East Coast. That which is gutted is, in order to save time, so wastefully treated that 1,000 lb. of round ungutted fish yield just 500 lb. of gutted fish, the heads and guts being frequently thrown away, though sometimes used as manure.

The chief reason why this excellent fish is thus misused is the necessity for great haste if cured. The fish when caught are thrown into the boat which waits till it has a full load, perhaps for some hours in

the hot sun, for it is usually a daylight fishery; the heat and the bruising caused by the weight of the piles of fish, induce rapid decomposition. Hence when the fish get to shore they are often in a poor or even an advanced condition, and since a ton may contain above 50,000 fish and labour is scarce, it is impossible to gut many fish before complete taint sets in, so that the bulk of large catches has, perforce, to be spread on the beaches to dry into manure. Hence it became necessary to try and cure without gutting; this is not unusual, for in America herring are practically *always* cured "round," i.e., ungutted; so also bloaters in England, and pilchards which are practically large sardines. The pilchard cure was mentioned in all essentials in paragraph 138 of my book on the curing of fish, and Mr. Hornell has recently supplied certain details. Accordingly I experimented with much success on this mode of cure, large modifications in the Cornish method being necessary. I find that the sardines can be brought straight from the boat, "roused" at once with salt in a large trough, and put into the salting tubs, wholly ungutted, without any fear of decomposition; the proportion of salt first used was one of salt to three or four of fish, but this has been successfully decreased to one to six and even one to seven. Fish so treated in December, January and February were—with exceptions—perfectly good in April; in some cases they were left in their brine, in which case a quantity of the oil usually rose to the surface and formed an air proof protection unless skimmed off as a valuable product; or they were drained of their brine and perhaps repacked in wooden cases or kerosine tins with a sprinkling of fresh salt; fish treated in this latter way in December and January remained good for months and are attractive in appearance. Consequently I can now take a ton—canoe load—of sardine and make them safe from all danger for months at least, by a single hour's work occupied in washing, rousing with salt, and placing in the tubs. The method is entirely novel in this country and successful, but much further practice is required to ascertain complete data and the best methods; these will be published hereafter. The fish thus prepared smoke excellently, and keep good and savoury for several months.

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As compared with gutted and dried sardine they have disadvantages; they require more salt; they are moist—though not in brine—and consequently above twice as heavy, and they require better packing; hence both packing and transport charges are comparatively heavy. *Per contra*, they provide more and more digestible nutriment, while the cost of salt is balanced by the absence of the cost and heavy loss of gutting. The advantage, however, which outweighs all else is that by the rapidity and ease of curing any desired quantity of sardines may now be turned into good food; under this method it is even possible to take out a large boat to the sardine grounds, if at all distant, and place the fish at once in salt *while at sea*. Moreover, they can be taken from the tubs at any time and smoked or otherwise dealt with.

On the large scale these pilchard-cured fish can be landed in Madras at Rs. 45 to Rs. 50 per ton of cured fish, all costs, curers' profit, packing and rail charges included, or 50 to 45 lb. per rupee; hence they can there be sold retail at 2 lb. per anna. The cost may eventually be somewhat decreased.

But the method of salting ungutted sardine enables us to deal with the fish in another way; by putting the fish into salt at 1 to 7 (1 lb. salt to 7 lb. fish) any quantity of fish can be made safe for some days and can be taken out at leisure and dried or smoked; in this way while the delay and cost of gutting is avoided, the fish, being dried, can be very cheaply packed and transported; this is a middle way between the pilchard cure and the present dry cure of gutted fish.

12. *Fish-oil and guano.*—But for some years, in the absence of rapid curing, sardines will be made into fertiliser, and it has been therefore necessary to introduce better methods by which the valuable oil should not be wasted while the nitrogen and phosphoric acid should be fully conserved. The matter was mentioned in paragraph 23 of my previous annual report and has now been carried a stage further both by Mr. U. Choyi and myself. Mr. Choyi has now three presses and has succeeded in placing marketable crude brown oil, and good guano of 8·3 per cent nitrogen and 7·95 per cent phosphoric acid, on the market at remunerative rates. My own work was preliminary only, intended to devise

methods of obtaining better qualities of oil and guano, to avoid waste of material and labour, and to utilise waste matter. The matter will have to be carried further before publication of results, but it may be said at once that instead of coarse brown oil I have produced by the simplest methods and plant fine yellow oil of the *best* quality, never before obtained on the coast and quite fit for use as an edible; that the largest yield of oil—so large that I will wait for further experiments before giving percentages—was obtained from the guts now mostly wasted and which the local curers derided as oil producers; and that I have ascertained the causes of considerable waste.

It may be said from experience that during the ordinary season 10 tons of fresh sardine at present produce 2 tons of dry guano of the constituents given above, and 1 ton, i.e., 10 per cent, of oil on an average of fat and moderately fat fish; the outturn of oil can be improved in quality and quantity, but the guano only, if at all, in quality. Plant has now been or is being prepared for the thorough examination of this important industrial work.

13. *Miscellaneous.*—Preliminary experiments in fish pastes were begun, and the results warrant developments with plant already obtained for the purpose. The use for a second and third time of *brine* derived from heavy salting has been very successful and effects a notable economy; this is possible because the fish in salt are perfectly clean and untainted and the tubs sanitary, so that the resulting brine is good; it is also filtered through clean sand, and sometimes wood charcoal, and may then be used several times; such brine has been kept quite sweet for a month. *Brining* with saturated brine is found, for some purposes, superior to salt, the strength being kept up by loose salt; a better surface is thus given to lightly smoked fish; a few minutes in brine will preserve fish fresh—with a slight saline flavour when raw which disappears in cooking—for a day or two, especially if 0·5 per cent of the weight of the fish, i.e., 1 lb. per 200 lb., be added of boric preservative. The dirty salt received from the salt pans has been greatly improved for fish-curing by a *washing* with saturated brine, and fish cured with this salt are clean from the grit and dirty surface which are apt to characterize fish

cured with unwashed salt; the magnesium and calcium salts however are, of course, unaffected by washing, and I have had to experiment largely with English salt. It has been found that in a tropical climate salt "strikes" much harder and more quickly than in temperate regions; British practice is consequently apt to be misleading as to the quantity and period of salting. It has also been proved by numerous experiments that ungutted sardines roused with salt in such small quantities as 1 to 12, 1 to 16, and even 1 to 20, will keep good for many hours; in one case salt at 1 to 16 preserved the fish perfectly for above 36 hours; hence fish can be kept from putrefaction while awaiting gutting, etc.

14. *Utilisation of waste.*—Pits were dug at one end of the yard and lined with wood, mats, etc. These were gradually filled with offal from gutted fish, failed experiments, etc., with a modicum of ash from the municipal cinerator and of quicklime. The result after several months has been a quantity of manure which has been dried and bagged; its analysis has not yet been obtained. Except on rare and very temporary occasions the presence of such pits in the yard was absolutely unnoticeable by the senses, so that we got rid of our offal—and much more—not only without nuisance but with considerable gain. The quantity of offal available in the vicinity is shown by the fact that a wood-lined pit holding about 130 cubic feet was filled to the brim in one afternoon of large catches with sardine offal from the neighbouring gutting places, and much more was available. As shown above, however, sardine offal should first be boiled for oil before consignment to the manure pit, and this has been effected in the Experimental Station with very notable results. By the common methods of gutting, 10,000 tons of valuable stuff containing large quantities of oil and fertiliser are available for every 20,000 tons of sardine caught; this as per actuals should yield at least 1,000 tons of oil, worth Rs. 12 lakhs, besides guano. This at present is almost entirely wasted, besides the manure contained in immense quantities of other fish offal, fish bones, etc.

15. *Prices of fish fresh and cured as ascertained by practice at the Experimental Station, etc.*—Fish, mostly prime, were, according to contract, brought in by the Ratnagiri boats at rates which were usually 20 to 25

per cent below beach prices ; seer cost just 1 anna per lb.; varian (small seer), valei (Chirocentrus dorab) and pomfret (usually black) which formed the bulk of the fish, cost Rs. 10, Rs. 10, and Rs. 7 per hundred round fish respectively, or about $9\frac{1}{2}$, 7, and 8 pies per lb. Varian and pomfret when cured for Colombo sold at the yard wholesale at Rs. 16 and Rs. 12 per 100 respectively or, at their cured weights, 2 and $2\frac{1}{4}$ annas per pound ; valei also sold at Rs. 16 or about 1·4 anna per lb., being a larger coarser, and more bony fish. Since salt—at fish-curing yard prices, viz., 10 annas per maund—and labour charged at local rates, cost less than Rs. 2 per 100, there was a fair profit ; had the fish been bought on the beach the profit would have been small. The additional cost of smoking is trifling, since the labour of placing fish in and removing them from the kiln is about equal to or less than that involved in drying the fish during several days, while the cost of the chips and sawdust used in smoking, is, per pound, infinitesimal.

16. The cost of mackerel and sardines is very different. *Mackerel* are sold per 1,000 usually at from Rs. 2 to Rs. 3, and ordinarily weigh round slightly over 2 cwt., or 200 lb. when gutted ; dried or smoked they weigh 120 to 125 lb., and moist (salted and drained) about 165 lb. The usual wholesale price of cured (salted and dried) gutted mackerel is about Rs. 4 when bought fresh at about Rs. 2 ; the local allowance by merchants to curers for salt, at fish-curing yard rates, is 4 annas, and labour 4 to 5 annas, per 1,000 ; salt is, however, allowed at 8 annas when fish are cured for Colombo ; labour includes all operations from the boat to the godown, viz., carriage, gutting, application of, but not cost of, salt, drying, etc. Hence the cured fish may cost Rs. 3 per 1,000, and are sold at Rs. 4 including merchants' profit. The Station mackerel however sold at Rs. 4–15–0 and Rs. 4–14–0 per 1,000 when fish-curing yard mackerel sold at Rs. 4–2–0, so that on nearly 40,000 a good profit was made ; this was due to their soundness and good appearance. Hence 1,000 well salted and dried mackerel, weighing full 120 lb., of good appearance, absolutely free from taint, and warranted to keep for several months, can be sold *ex*-yard at Rs. 5, or packed in gunny and f.o.r. Cannanore at Rs. 5–8–0, these prices giving a good profit, if salt and labour be

taken at the rates paid in the fish-curing yards; at ordinary rates for duty-paid salt 8 annas more covers the extra cost. A wooden one-dozen case contains just 340 of such fish, and weighing gross about 52 lb. (40 to 42 lb. of fish) can be sold f.o.r. Cannanore for Rs. 2. Salted mackerel not sun-dried but simply drained and slightly moist, can be similarly sold, but the box averages about 64 lb. with 54 lb. of fish; this product will not keep so long as sun-dried fish but is otherwise desirable; the charge is similar though labour is less, because more salt is used and the fish may be in salt for some days till a demand arises. Smoked mackerel, a very good product, packs at 300 to the box which, with 34 lb. of fish, averages 44 lb.; the cost is similar; these fish keep a long time, and February cured fish are now (July) in good order.

17. *Sardines* cost, when sufficiently abundant for large work, about Rs. 12 or a little less, per ton, taking a large canoe load of 5 kallis of between 5 and 6 maunds each, as 1 ton. By the pilchard cure the cost of salt and all labour does not exceed Rs. 4 to Rs. 5 per ton of fish (at Rs. 2–12–0 for salt at 10 annas per maund, and Rs. 2 per ton for labour) so that the ton of fresh fish costs, when cured, Rs. 16 to Rs. 17 in all, and taking $1\frac{1}{4}$ tons of fresh fish to make one ton of cured fish the latter costs Rs. 21 per ton, or nearly 7 lb. per anna. To this must be added the cost of packing cases, usually cheap wooden boxes or, for small quantities, kerosine tins with covers. A one dozen case costing 4 annas holds 48 to 54 lb. of moist, pilchard-cured sardine, so that the fish cost about 8 annas. If the case be sold f.o.r. Cannanore at Re. 1, the fish will be sold at 12 annas, giving a profit of about 50 per cent. A kerosine tin of such sardine weighs 40 lb. gross and contains $37\frac{1}{2}$ lb. of fish; this can be sold for about 12 annas if the tin can be got for 4 annas.

If, however, these pilchard-cured fish are either dried or smoked, the packing charges can be greatly reduced; I hold smoked ungutted sardines, now above four months old, which have travelled hundreds of miles in a common package, and have been left loose in a box; they are still (July) in excellent condition and flavour, and quite unbroken; these can be sold with a good profit at about Rs. 50 to Rs. 55 per ton (equal to nearly 2 tons of fresh fish) or $2\frac{1}{2}$ lb. per anna packed in mats, etc., and

f.o.r. Cannanore. The pronounced flavour of these smoked ungutted sardines is absolutely free from taint, and arises solely from the character of the fish and from the salt and smoke, combined with the natural oil. The Indian consumer should approve of these goods as a substitute for tainted fish.

The above figures assume salt at fish-curing yard rates, viz., 10 annas per maund of 82 lb., not at the Cannanore Bazaar rates of Rs. 1–10–0 per maund; also labour at local rates.

Dried sardines gutted in local fashion were sold at the Station at Rs. 3–4–0 to Rs. 3–13–8 per 10,000 which, in the smaller sizes, represent about one maund. Hence the ton of such fish represents 270,000 fish worth Rs. 88 to Rs. 103, averaging Rs. 95. But 270,000 small sardines represent about 5 tons of fresh fish of which a full half is lost in gutting, and the resulting 2½ tons dry into about 1 ton; these 5 tons cost about Rs. 60, so that after adding about Rs. 5–8–0 being the cost of salt on 2½ tons of gutted fish, viz., 8½ maunds at annas 10, and labour, etc., Rs. 12–8–0 for gutting and handling 270,000 fish weighing 5 tons when ungutted, or Rs. 78 in all, there is a fair profit. The waste of material in gutting is here apparent; it is slightly less with larger fish of which 28,000 sometimes go to the ton instead of 50,000 or more of small ones. Fish placed ungutted in salt, as now practised at the Station, and then dried, were found to weigh 180 lb. per 10,000 and 36,500 weighing 655 lb. were sold for nearly Rs. 15, or Rs. 50 per ton. In this method the ton of dry fish represents about 2¼ tons of fresh fish—dryage being the only source of waste—costing Rs. 27; salt at 1 to 6 on the gross weight cost, at annas 10 per maund, Rs. 6–8–0, and labour not more than Rs. 4–8–0 at Rs. 2 per ton since there was no gutting and a less gross weight was handled; hence the cost per ton of dried fish was not above Rs. 39, which gives a profit of Rs. 11. Under the Station system of utilising old brine the cost has been decreased and profits improved, whether for gutted or ungutted fish. As mentioned above, the real profit from the Station method of salting and drying without gutting is the ability to save, *as untainted food*, as many tons of sardines as can be brought to shore, whereas the slow and laborious process of

gutting prevents the use of more than a fraction of the catches when abundant.

18. *Organization of a trade.*—The experience of the past year enforces the commonplace that if the industry and trade are to be seriously developed *business knowledge and business organization* are necessary preliminaries ; good products are useless if on the one hand they are not acceptable or on the other are not known or introduced to the public.

As regards *acceptability*, my Personal Assistant, Mr. V. Govindan, made a tour of special enquiry and has obtained valuable first-hand information and facts. He found that existing markets are somewhat particular; the fish-eaters of Madras City seem to demand moist fish with light salt, and consequently, a certain amount of taint or high flavour ; fish cured as for Colombo, viz., well salted, dry, and absolutely free from such flavour, are not desired ; apparently it is not merely a question of cheap price, but of custom. Not only so but in the Tamil districts of the East Coast most of the fish seems to be consumed when tainted either because of necessity or from preference, more probably the former; a large proportion of the supply is West Coast fish not good enough for Ceylon, or it consists of mackerel and sardines cured absolutely without salt and undistinguishable—sardines—from the fish dried on the beaches as manure ; the moist fish has little salt and is consequently tainted and maggotty ; the fish of the so-called "Madura cure" is soft and pasty. Much of this is due to the demand for excessive cheapness, part to originally defective curing ; the two reasons act and react on one another ; the cheapest goods are required and these can only be supplied of bad quality ; being of bad quality no respectable persons purchase it. As an example, the saltless sardines, containing a minimum of nourishment, are kept on the market until they are absolutely unfit for anything except manure ; mackerel bought fresh on the West Coast at Rs. 2 per 1,000 are required to be sold at Rs. 3 per 1,000 in South Arcot ; I have been told that Tamil coolies in Ceylon used to filch for food portions of the dried sardines used on the estates as manure, being so similar to the stuff they were accustomed to in India. My Assistant also found that the public was quite unaware that "karuvad"

(salt fish) could be anything but the stuff usually found on the market, and actually considered well cured untainted fish as "not up to the mark" because it had not the accustomed appearance and smell. It is, of course, obvious that men who for ages have accepted and have come to approve of "high" or rotten goods as their only fish supply, will not readily change to other and less highly flavoured products. Nevertheless Mr. Govindan considers that the mass are guided largely by cheapness and that if we can supply good products at equally cheap or cheaper rates, the market will readily accept them ; this I think is obvious ; the poorer classes will buy in the cheapest market even if the products are good.

19. But there is a far larger and better market to be considered, viz., the *potential* market consisting of the immense number of fairly well-to-do persons who would eat fish if it were provided of good quality and appearance even at a slightly increased price. For such persons I consider that it remains for us to create both the supply and the specific taste ; as in Ceylon good dried fish have taken the place of bad stuff in the better class markets, so we can create a demand for good products by supplying good products whether they be dry or moist, heavily or lightly salted, plain or smoked, and so on ; the prime requisites are good appearance, good natural flavour, wholesome food, and reasonable price. Now I can provide all these requisites with ease ; as shown in paragraph 15 to 17, I can provide fishery products of good and even excellent quality at the most moderate prices, and even for the poorer classes at rates as low as can be desired but without the tainted flavour they seem to need, though I can substitute an excellent and pronounced flavour by good salting and smoking. But unless I can put these goods on the market *not* as casual parcels at irregular intervals and in small quantities but persistently, habitually, visibly, and in bulk so that all may buy, it is impossible to create such market for the new goods, and a main lesson of the past year, from my own experience and, regrettably, that of others, is that it is necessary to take one or two particular localities, open a shop at each such locality and keep it supplied with really good products ; a locality, for instance, such as a large inland town where all social strata are well

represented. Various enquiries, especially that of my Personal Assistant, show that the conditions of the fish trade are not at all satisfactory ; as might be inferred from the status of the fishing and curing classes, there is no such organization or business power as would enable them to hold their own with the up-country wholesale merchants who consequently have too much power in their hands as regards both the consignors from the coast and the retailers in the markets ; goods sent from the coast are, on receipt, often said to be damaged, or unsuitable for the market, etc. etc., and the consignors have to take what they can get ; retailers and consumers similarly have to buy what the wholesale men choose and at their prices which are kept up in various ways ; one merchant in a large town suggested the fable that prices were high because Europeans have come and swept the West Coast with vast copper wire nets many miles long, and sent off the fish to Europe so that none were available for inland, and so forth. Even when no tricks are played the commission demanded or the profit expected as wholesalers is ruinously large, simply because there is either a monopoly or a ring. Now just as Government is alone able to step in and experiment on new methods, so it rests with Government to introduce untainted, good, but—on that account—novel products to a market hitherto undeveloped ; the wholesale merchants will not risk new products or attempt a new market with untried goods, and though several agreed to do so, none has actually come forward. Hence the necessity for temporary trade, in which Government are, as in new catching and curing methods, *simply pioneers*, actually developing a trade and markets which do not at present exist and will not exist till so developed ; when developed, Government operations will cease, and the fish trade obtain the whole benefit of the Government pioneer operations. As pointed out above, moreover, organization is specially needed in the transport and disposal of fish either fresh or lightly cured.

20. *Oyster culture.*—This experiment, at Ennore, alluded to in paragraph 17 of last year's report, was again tried in September-December 1909 by the placing of fresh tile collectors in reserved area of the backwater ; the result was precisely similar to that of 1908 as to the time and occasion of the deposit of spat and the growth

of the young oyster. More than that, on examination in March 1910 it was found that the young oysters deposited as spat in October 1908 were *mature* measuring up to $4\frac{1}{8} \times 3\frac{1}{4}$ inches, and $1\frac{1}{2}$ inches in thickness, while the flavour was excellent. Hence it is now a demonstrated fact that oyster spat can be obtained in abundance by the simplest of processes and that the oysters are fully marketable in 18 months from spat fall. This matter has been fully reported on in Mr. Hornell's two papers, on oyster culture at Arcachon and on a proposed oyster farm at Pulicat, submitted with my letter No. 233, dated the 1st July 1910; the beginnings of an oyster industry are now in sight, and ten years may see it well established as a profitable business both in Madras and elsewhere.

21. *Pearl and Chank Fisheries.*—These were taken over from the Collector of Tinnevelly and Port Officer of Tuticorin from 1st April 1909, and have been worked by "Fisheries" throughout the year. The pearl bank inspection begun in March 1909 was concluded in April; no pearl oysters were found. The chank fishery continued till May with good results as reported in the Superintendent's letter read in G.O., No. 3076, Revenue, dated 13th November 1909; the proceeds of the fishery were 272,841 first sort shells sold at Rs. 99 odd per 1,000 for a sum of Rs. 27,536 including undersized and wormed shells at Rs. 6 per 1,000; deducting the sums paid to the divers and cost of management, the net proceeds were Rs. 18,397. Mr. V. Govindan, Personal Assistant, was in charge from May to November during Mr. Hornell's absence in Europe and did good work throughout; from November Mr. Hornell was in charge. During the season 1909–10 various concessions sanctioned by Government were made to the divers, such as the promise of 8 pies per shell instead of 6 for all full-sized shells obtained above 3 lakhs; bad weather prevented this concession from coming into operation; a small bonus per canoe was however granted to the divers; a channel was also re-opened so that the boats could get close to the chank godown. By the purchase of the motor whale-boat "Pearl" received at the end of January, considerable aid was given to the divers by towing their canoes when calms would otherwise have caused entire inability to go to sea; this happened on 15 days and she thus enabled the divers to obtain 17,000

shells, of which the net value to Government was Rs. 1,530, which would otherwise have remained unfished; hence she paid half her capital cost in three months and greatly assisted as well as profited the divers. As a result of circulars, etc., by Mr. Hornell, issued to the trade in Calcutta, etc., during the year, greatly enhanced prices were obtained at the recent sale of the shells, viz., Rs. 121 odd per 1,000 shells above $2\frac{1}{4}$ inches in diameter, so that the gross proceeds for 338,661 shells of all sizes were Rs. 37,217, and net Rs. 26,924, being the best for many years; these figures are given here as being the result of the work of the year under report, for which full details will be found in the special report which accompanies this general one.

22. *Inland.*—The work of Mr. Wilson, Piscicultural Expert, has been mentioned above, but apart from the trout hatchery which is under the Collector of the Nilgiris, the first piscicultural work placed in operation in inland waters was begun during the year, viz., the hilsa hatchery at the Lower Anicut leased fishery on the Coleroon. This was mentioned as a suggestion in paragraph 25 of my last year's report, and was sanctioned by Government in G.Os. No. 1219, Revenue, dated 5th May 1909, and No. 2231, Revenue, dated 13th August 1909; work was completed in August, the hatchery being placed at the Public Works bungalow at the Lower Anicut; the plant consisted of the usual water tanks, a battery of Macdonald hatching jars obtained from America by the courtesy of the United States of America Fishery Commission, and accessories. Mr. Wilson arranged with fishermen for a supply of ripe ova, which were fertilised, hatched out in the jars, and passed thence into the reception tanks. The high temperature (80° F.) of the water at the hatching point, which was a verandah of the bungalow, proved a difficulty, so that it was necessary to put the fry out into a sheltered and reedy spot in the river almost as soon as they were hatched. Being the first of a series of hatchings and conducted under previously unknown conditions, nothing can yet be predicted as to results in increasing the hilsa supply; it is however now ascertained (1) that hilsa can be successfully hatched artificially in large quantities, (2) that the period of incubation is on and from the third day at a temperature of about 80° F.; probably this is

the maximum temperature advisable. Much difficulty was found in inducing the fishermen to supply ova, especially of a suitable and uninjured character ; this and the temperature question will have to be arranged for.

Mr. Wilson also successfully carried fertilised hilsa ova to the West Coast where he deposited many thousands of eggs in a part of the Ponnani river in good positions such as the fish would select if running up the river to spawn ; it will be remembered that at present there are no hilsa on the West Coast.

General.—Much general work, the results of which cannot be reported on paper, was done during the year, such as the study by Mr. Hornell and myself in Europe of motors, boats, fish and oyster culture, fish-curing, curing and canning plant, etc., to which may be added numerous interviews with business men either for obtaining or for giving information. Mr. Wilson's chief work has also been that of investigation and the preparation of plans as noted above. Correspondence has been considerable, and includes enquiries during the year from officials in Bengal, Eastern Bengal, the Punjab, Bombay, Gwalior, etc., on the matter of fishery operations. The stations have been visited by quite a number of persons interested, of whom some spent several days in studying operations in view to imitation ; several persons have started fish-curing as a direct consequence of such studies and were at work, though not perhaps in a large way, at the end of the year ; the representative of a Karachi firm came specially to Cannanore, studied the work there going on, and made business proposals regarding a supply of cured fish ; several firms and individuals of this Presidency have also made enquiries, especially as regards the fish-oil and guano industry which is likely to develop this current year along the lines which I have suggested—that of numerous very small factories scattered along the coast line—and which Mr. Choyi of Cannanore has been the first to adopt with, I am glad to say, good success which I hope to see increased. Several persons proposed to come or to send delegates to work as regular students in the stations ; two of these actually came, one of whom is a young man from Travancore with some capital who shaped well during several months at Cannanore and will be with me next season.

My book on the "Preservation and Cure of Fish" (G.O. Mis. No. 351, Revenue, dated 10th February 1909) met with some approval, so that the edition was exhausted during the year and a further one, embodying the results of Madras experience, is called for.

A large amount of energy, time, and some material has been spent on experiment, much of which was only useful as showing what not to do; it requires much patience, time, and some money to work out to success experiments which often cannot be immediately repeated or which last only for a brief season, and which are not only wholly novel to the country but have to be carried out by inexperienced hands and under conditions absolutely different from those of the countries where they originally developed; the results, moreover, though often successful, may be found to be unacceptable to the existing markets. In a recent American Fishery Bulletin it is remarked that "the most valuable branch "of the American herring industry is the canning of "small herring under the name of sardines. The business began in 1875, *preceded by six or seven years of "experimental work*," etc. So in the middle of the 19th century it took the French Government twelve years of experimental work at Arcachon merely to revive and to place on a new footing the ancient but decadent oyster industry. I need hardly say that if in the energetic, businesslike States and in the temperate climate of Maine, a single branch of fishery work, and that a more or less mechanical and well-known one, had to be preceded by "six or seven years of experiment," we can hardly expect to be more fortunate, more skilful in attempting to develop in ways suited to this tropical climate and amongst and with these tropical people a whole series of fishery operations and products developed amidst other conditions and other folk, beginning with the fishing net and ending only with the consumer.

Letter—from Sir F. A. Nicholson, K.C.I.E., Honorary Director—Madras Fisheries.

Dated—Madras, the 10th August 1914.

I have the honour to submit my general report for the year 1910–11.

2. *Staff.*—This remained as in 1909–1910, viz., myself, Messrs. Wilson, Hornell and V. Govindan as assistants, two sub-assistants, and subordinates.

3. *Work done.*—This consisted of operations at the Cannanore experimental station with demonstrations on the West Coast, the preparation and execution of various piscicultural projects, a certain amount of investigation, and a considerable amount of educative and stimulative work amongst the public and individuals; these will all be detailed below. The chank fishery, though mentioned briefly, is the subject of the usual separate report.

4. *Work done individually.*—I continued as Honorary Director in general charge of operations with special charge of the Cannanore experimental station, which, this year, took up more particularly the manufactures of oil and guano from sardines, continuing, however, curing experiments.

Mr. H. C. Wilson, Piscicultural expert, continued his trout work on the Nilgiris, including the successful importation at his own expense of a batch of "wild trout" late in the year; also the conservation of the upper waters of the Moyar and Bhavāni. The Sunkesula fish farm scheme was under construction, several large tanks were stocked, and other projects, notably the Kanigiri reservoir (Nellore) project, have been worked out and either sanctioned or sent up to Government. Mr. Wilson's advice has also been sought from other provinces by various people and associations—see below *s.v.* "Pisciculture."

Mr. J. Hornell, F.L.S., continued as Superintendent of the Pearl and Chank Fisheries and as Marine Assistant, the dual service giving abundance of work. His report (Bulletin No. 5) on oyster culture at Arcachon and its lessons for India was characterized by Government as "a very valuable and practical piece of work." This report was based on a long personal visit to Arcachon when on furlough in 1909, and has resulted in a practical scheme for oyster culture now in actual operation at

Pulicat. A second report (Bulletin No. 6) on "Marine Fish Farming," also based on his tour in France and Italy, is before Government. He visited Bengal and Eastern Bengal on chank service and has reported results and made suggestions now before Government, while a further report on the technical and artistic aspects of the industry has been in active preparation. His advice on many practical matters especially regarding the proposed Inspection Schooner, fishing possibilities, etc., has been of great value to myself and to enquirers.

Mr. V. Govindan, B.A., F.Z.S., continued as my Personal Assistant and rendered extremely valuable service of a character which, perhaps, only himself, as an Indian thoroughly acquainted with the fisher-folk, their work, and their needs, and deeply interested therein, could fully render, viz., in conversing and arguing familiarly with the various classes, informing and persuading them regarding new methods of fishing, curing, manufacturing, and co-operating, as well as in ascertaining and reporting their needs, ideas, objections and difficulties; he has also carried out demonstrations of a practical character in the fish-oil and guano business, and much of the success which is attending the development of this new industry is due to him. He has also directly assisted me in the numerous details of my work as Director.

Cannanore Experimental Station.

5. The main operations carried on here were—

(1) the preparation of dried salt fish of superior quality;

(2) the treatment of fish, large and small, by pickling;

(3) the preparation of lightly cured fish;

(4) miscellaneous;

(5) the manufacture of fish-oil and guano from the oil-sardine (*Clupea longiceps*).

6. *Dried salt fish.*—The fish was mostly obtained, as in 1909–10, by hiring two Ratnagiri boats. The season, October to December, was extremely bad for driftnet fishing owing to the protraction of the south-west monsoon; the two boats fished for only 49 and 42 days respectively and obtained only 22,307 lb. (10 tons) of

clean (gutted) fish, whereas in 1909, they fished for about 20 days for a local merchant and 43 days for the station, catching during the latter 43 days, 38,000 lb. of round fish (besides their food and other fish) or nearly 33,000 lb. of clean fish of which the prime portion was larger than in the present year, and the total value of the catches was Rs. 1,600. The total amount paid this year for 22,307 lb. clean fish was Rs. 866 which works out at about 7·4 pies per lb. or practically 6·5 pies per lb. for round (ungutted) fish, allowing about 15 per cent for gutting. Only 55 per cent was prime fish (seer, medium and small seer and pomfret) and the rest was coarse fish including catfish and small shark. The boats also retained enough of their catches for their own consumption and some—a little—for carrying home at the end of the season. The largest catch in one day by the two boats was 2,101 lb. of gutted fish valued at Rs. 71.

7. *Pickling.*—Pickling, i.e., salting in barrels for sale as wet fish, is a method new to this country; it was not fully carried out owing to the impossibility of obtaining proper barrels, absurd prices being asked for unsuitable articles. The matter will again be taken up. But a quantity of varian, pomfret, and mackerel were placed in open, roughly lidded boxes and tubs, in one to three salt (1 lb. salt to 3 lb. of fish) as in western countries, and are perfectly good at the time of writing (June) though laid down in January and February; some of the surface fish had become slightly pink, but the fish are all good and are available for sale, and are being used successfully for freshening and smoking, etc., during the monsoon when dried fish is hardly procurable.

8. *Light or mild cured fish.*—This highly important experiment was developed; the object is to place on the inland market an article so lightly cured as to be a substitute for fresh fish which is, at present, unattainable except in a few places where a high-price demand is so considerable (*e.g.*, Ootacamund, Bangalore, etc.) that it pays to ice fish; the light cured article is for *general* consumption. By a new method wholly free from the use of preservatives, fish can be sufficiently cured to be a fair substitute for fresh fish, only slightly saline, and good for a week; if smoked the fish is an excellent substitute for smoked haddock. Parcels of such fish both

unsmoked and smoked, have been repeatedly consumed by myself and friends with satisfaction more than a week after despatch from the station and frequently four days *en route*. By the end of next season the experiment will be developed sufficiently for publication; at present the mode of packing, almost as important in this country as the curing, requires study and experiment. But, as stated last year, the sale of such fish requires thorough organization, since the supply and demand must be so adjusted that there shall never be a stock long on hand; it must be sold almost immediately. If my experiments prove as successful as they promise, a very wide market and large demand should follow.

9. *Miscellaneous.*—This includes further experiments in *washing salt*; the ordinary salt, as supplied to the fish-curing yards, has so large a proportion of dust, mud, sand, small shells, etc., that it is useless to attempt first class curing with it; the cleanest fish eat gritty. By washing the salt in a sieve in a tub of semi-saturated brine, an operation which a girl can carry out alone at the rate of a maund per 20 minutes, and draining and drying the washed salt, a very good and clean article is obtained with a loss of something like 10 per cent of which about half is mud and rubbish. This raises the price of a maund from 10 to about 11 annas. The salt is then almost as good as British duty-paid salt as regards cleanness, but seems inferior as regards contents of sodium chloride.

Old brine obtained in salting superior fish such as varian, seer, pomfret, mackerel, etc., has been largely used in brining sardines and other thin and small fish. Our fish is so clean that the brine is perfectly good; it has been used either filtered—through sand and charcoal, etc.—or, latterly, boiled; it is found that an addition of about one-third further salt brings the brine back to saturation and keeps up its strength during brining. This, therefore, represents a gain of two-thirds of the salt used in salting sardines, etc., while the sardines gain a flavour which is distinctly appreciated by purchasers. But the method can only be practised safely when all the conditions of cleanliness are observed.

Attempts have been made to lessen the dangers from *flies*. In Virginia (United States of America) and probably in other States, no factory dealing in fish is allowed to carry on business in the fly season unless *all*

operations are conducted within fly-proof rooms. My drying scaffolds and flakes readily admit of being covered with mosquito net and this is found to protect the fish during the moist stage. The method will be developed next season.

Canning was not begun; a suitable building has, however, been rented, and the plant has been set up; by the courtesy of Messrs. T. Stanes & Co. of Coimbatore, to whom thanks are due, two artisans (both now qualified as engine drivers) were trained at their Coffee Works in the making of cans; they have been practising with our plant, and as a large quantity of tin plate, oil, etc., is now on hand, I hope to start next September.

10. *Fish-oil and fish guano.*—A main object pursued at the station during the season was the preparation of fish-oil and fish-guano from the oil-sardine (*Clupea longiceps*). A detailed paper is being drawn up on the subject and only salient points will here be mentioned. Above 30 tons of fresh sardine and sardine offal were used in the experiments; all parcels of fish, fuel, etc., were weighed, as also the resulting products, and the various weighments registered, so that accurate data were obtained.

The object of the experimental work was as follows: sardines in many thousands of tons have long been dried whole on the beach for manure; by this rude process not only is the whole of the oil dried up and utterly wasted and lost, but, as it coagulates, it firmly agglutinates to the fish a large quantity of sand, so that the article frequently shows 30 per cent and more of sand, and moreover much of the nitrogen is lost by putrefaction, while occasionally, as during this last season, immense quantities drying on the beach are wholly lost by inopportune rain. Hence the planter buys a quantity of coagulated oil which is worse than useless, and twice the quantity of sand; as expressed in a report from Ceylon, enough sand is sent to restore Adam's Bridge. In some few cases there has been a small manufacture of oil, by boiling in ordinary earthen chatties, in which case the residue is thrown away; or the fish was allowed to putrefy in vessels and the oil skimmed off and the foul residue thrown away or buried as a nuisance; in some places and months the guts obtained in gutting the fish for food have been used as manure, in which case the valuable oil is lost. Hence in every way the gravest

loss and waste, while the process of putrefying or of beach-drying is sanitarily offensive. If only 50,000 tons —a low estimate—are annually dried on the beach, the oil thus *totally* lost is something like 6,000 tons, worth about 10 lakhs of rupees, and if only 2 per cent of the nitrogen is lost by putrefaction and the ravages of maggots and insects, there is a further loss of about 2 lakhs. Hence it has been sought to minimize this loss, improve the products, and remove a sanitary nuisance by devising new methods of dealing with the sardine.

Under the new system the fish (or guts) are boiled in open pans over a fire, and the boiling stuff is then pressed for oil; the pressed scrap is dried in the sun and forms guano; in this way, the whole of the oil is obtained as a very valuable marketable product, while the fish (tissues and bone) are reduced to a friable mass one-fifth of the weight of the green fish and readily assimilable as manure, while the process is absolutely inoffensive and free from sanitary objection. This process was devised in 1908 by "Fisheries" from the example of the American farmers, etc., and urged upon the public; it was first taken up in 1908 by Mr. U. Choyi of Cannanore, and during the past season was the subject of much experiment in the station, and of commercial work by a number of interested persons. The season began with one and ended with about nine small factories in operation; moreover, quite a large number of persons have ordered boilers and presses, and it is expected that many more than the above nine works will be opened by the beginning of next season in September. As mentioned above, much of this is due to the propagandist work of my Assistant, Mr. V. Govindan, who rested not in pushing a knowledge of the process, and in demonstrating and in aiding people to obtain plant; meanwhile useful work also went on at the experimental station.

11. As produced in the minute factories, consisting of, perhaps, a couple of open boiling pans each holding half or two-thirds of a ton of fish, and three or four simple screw presses, the oil is dark brown in colour, of strong but not unpleasant smell, and containing a large percentage of stearine or fish tallow. No attempt is made to secure a finer oil; the boiling mass is scooped out into baskets, allowed to drain for a few minutes, then placed in coarse coir bags and pressed; the oil and water

run into a pit where they separate, when the oil is dipped out, placed in an open pan and boiled to drive off any remaining water ; the product is then barrelled. The pressed cakes are broken up and placed on mats in the sun, where the stuff dries ; when dry it contains below 5 per cent of moisture and is then bagged. The price obtained at the factory for oil is about Rs. 160 per ton of about 250 gallons (63 kerosene tins), at which price the middleman—usually a European firm—supplies casks and takes the cost of transport ; this is for the crude oil with its stearine. The guano fetches at the factory about Rs. 70 per ton and should have about 8·5 per cent of nitrogen and something higher in phosphoric acid.

12. In the experimental station efforts have been made to separate the oil into two qualities, viz., fine yellow and ordinary brown. It was found that when the mass is heated in the boiling pan most of the oil speedily rises to the surface and can be skimmed off ; this product is of a fine light or bright yellow, with very slight smell. After skimming, which produces about two-thirds of the whole oil obtained, the mass runs into draining boxes and thence is taken to the presses. Enquiries from Europe, of which I have had about 40, show an enormous demand for fish oil, and many of the enquiries, as well as specimens sent to me, show a large demand for the fine yellow oil of which the price is much higher than the brown oil ; a single leather factory has specially asked me to supply several thousand gallons of this fine oil, observing that the leather produced by the use of a sample was particularly good ; firms in Hamburg, Australia, etc., also specially enquire after this oil. The experiments will be renewed next season on a better scale and with better method ; *for the present*, the simplest and most remunerative plan for the small factories is to produce the ordinary brown oil without troubling about the finer qualities ; the method is cheap, very simple, and free from all technicalities, and there is so great a demand for this crude brown oil that it may be called unlimited and cannot be in any way satisfied even by the whole potential produce of the West Coast. Among other experiments tried at the station was an attempt to devise a method for cottage operations, acting on a hint derived from Mangalore

where a few people boil the fish for the oil in earthen chatties but *throw away* the solid materials; a small battery of chatties was tried with considerable success, but the chatties not infrequently break, resulting in some loss. Next season experiments will be tried with small metal chatties and a cheap lever press, so that persons with only Rs. 10 or Rs. 20 may utilize surplus sardines to advantage.

13. From work at the station, I am able now to give accurate data—for the late season only—as to outturn and cost, and to show the big profits obtained. The register kept shows the weight and cost of each parcel of fish or guts, the amount of labour spent in producing therefrom the oil and guano, the weight and cost of fuel used, and the outturn in oil and guano. What is true, however, of one season is not necessarily so of another; the fish differ largely in fat contents in different seasons, and while in 1909 the very fattest were obtained in March, those of March 1910 were almost useless as oil producers. Roughly speaking, 15 per cent of the weight of the raw fish can be obtained as crude oil from September to February inclusive, and 20 per cent as dry guano. This is for whole fish; if only "guts," which includes head, intestines, and a small part of the tissues, are used, the oil is about or above 15 per cent and the guano 18 or 19 per cent.

The figures for *whole* fish work out something as follows:—

Expenses.

	RS.
Ten tons green fish at Rs. 11 per ton	110
Labour in boiling and pressing	8
Labour in drying guano, etc.	6
Fuel at 160 lb. wood per ton of fish	6
Depreciation at 5 per cent on Rs. 300	15
Etceteras (interest, leakage, labour in filling and transporting casks, bagging, wages of maistries, etc.)	15
	160

Receipts.

Oil at 15 per cent = $1\frac{1}{2}$ tons at Rs. 160 per ton ...	240
Guano, two tons at Rs. 70	140
Total ...	380
Deduct expenses ...	160
Net profit ...	220

The cost of fish is often less than Rs. 11 per ton; depreciation at 5 per cent. is a high allowance on three or four days' use of the simple plant. But if the expenses for labour and fuel are 50 per cent higher than as above, which, however, are abstracts in round figures from my register, the rate of profit is surprising. If the outturn in oil be taken as low as $12\frac{1}{2}$ per cent or $1\frac{1}{4}$ tons, value Rs. 200, the profit is still remarkable. It will be seen that in any case the oil, *hitherto lost*, far more than pays all expenses, leaving the guano, at least, as clear profit.

Fish are, of course, not always procurable as the shoals are very mobile, and the little factories are therefore partly idle for many days in each month of the season; this—apart from the socio-economic question—is the reason why *small* factories, worked by small folk, are preferable to large central factories, the success of which is highly problematical especially in a tropical climate where fish cannot be brought from even moderate distances to a central factory without putrefaction setting in. Moreover, in these petty factories, the bulk of the labour is only engaged as needed, so that the running expenses on non-working days are inconsiderable. As repeatedly stated from 1908 onwards, the method advocated is that of hundreds of petty factories, each costing a *few hundred rupees*, scattered along the coast, producing oil and guano whenever possible, and—until co-operative societies are formed, which is our aim—selling their produce to middlemen who will lump the several parcels, and sell to the consumer practically uniform products under a guarantee of intrinsic value. This postulates middlemen—firms employing agents and dubashes, or well-to-do individuals, etc.—who will take the trouble to perambulate the coast, stimulating the small producer by advice and, if necessary, advances, controlling their methods and the character of their produce, and concentrating such produce in their own godowns.

14. In the experimental station the manufacture of oil and guano was also combined with that of edible food from the same individual sardines. The local method of gutting is to push the sardine slantwise against the edge of a knife held in the toes of the operating woman seated on the ground (in our station

this is a clean cement floor), so that slightly over half the fish, including the head and all intestines from the vent upwards, is removed at one stroke leaving solid flesh as the other half; it is possible—as frequently timed—to gut 40 fish per minute in this way. The guts contain more fat than the tissues, layers of white fat being readily visible. In 1,000 lb. of fish the guts portion may weigh 520 lb., and the tissue portion 450, the remainder being wastage (blood, fluid from guts, etc.). The guts thus separated were boiled and pressed in the usual way; a good deal more oil, sometimes reaching about 20 per cent of the gross weight of the guts, was usually obtained, but the percentage of guano was less since much of the guts is useless vegetable matter combined with mud. The oil was generally of very fine quality, since it separates easily and rapidly in the boiling pan and can be skimmed off as a pale yellow product; the guano is somewhat less rich in nitrogen than whole-fish guano, but more so in phosphoric acid.

The tissue half of the fish was treated as usual, viz., by placing in salt at 1 to 8 or in saturated brine from other fish.

Hence the balance sheet is something as follows, as ascertained from my registers:—

Expenses for oil and guano.

	RS.
Ten tons at Rs. 11 per ton	110
Labour for gutting at Rs. 1½ per ton	15
Do. for boiling and pressing 5⅓ tons of guts.	5
Do. for drying, etc.	4
Fuel at 160 lb. per ton for 5⅓ tons	4
Depreciation and repairs at 4 per cent on Rs. 300	12
Etceteras	10
	160

Expenses for edible portion.

Salt for 4½ tons fish at 1 to 8, say 16 maunds at 10 annas	10
Labour in salting, drying, etc., 4½ tons wet fish ...	10
	20
Total of all expenses ...	180

Receipts for oil and guano.

	Rs.
Oil at 16 per cent on $5\frac{1}{3}$ tons, nearly $\frac{6}{7}$ of a ton at Rs. 160, say	135
Guano at 18 per cent on $5\frac{1}{3}$ tons, nearly 1 ton at, say, Rs. 65	55
Total ...	190

Receipts for edible portion.

Two and a quarter tons dry sardine at Rs. 90, say	200
Grand total of receipts ...	390
Deduct expenses ...	180
Net profit ...	210

Hence the profit is practically the same as when whole sardines are boiled, with the advantage that nearly half the weight of fish is retained as direct food. The profit depends largely on the rate at which the edible portion is sold as food, here entered as only Rs. 90 per ton; since most of the inedible parts are removed and about two-thirds of the useless moisture, the somewhat oily dried fish are nearly solid food, and this food, if sold at 8 pies per lb., would fetch Rs. 93 per ton; much of the station sardine has been sold at prices about Rs. 90. Moreover, in one way our expenses for salt were less than stated, since boiled or filtered brine from other fish was used, *per contra* the salt was either washed or was English salt; the rate charged in the above table is what it would cost an ordinary fish-curing yard curer. It will be seen that all expenses are paid by the oil and guano, so that the proceeds of the edible fish are solid gain. Allowing that 10 tons of fish dry on the beach into 4 tons of sand-free manure (I have seen quantities which are mere shells), these dried fish, if costing when fresh Rs. 100, would, at an average of Rs. 30 per ton, fetch only Rs. 120; even 5 tons would fetch only Rs. 150. The real profits are made out of the $1\frac{1}{2}$ tons of sand which adhere to the 5 tons of fish, so that the gross return is Rs. 195 or a profit of Rs. 85. Hence not only is the profit far smaller, but the wastage of oil and nitrogen and the addition of sand are almost criminal. For further details my paper must be referred to.

15. Towards the end of the year Government sanctioned further experiments in a somewhat enlarged and improved factory which, like the present one, will serve as an example and place of research and instruction for those who seek to operate on a slightly larger scale and by more rapid methods, especially for the production of fine oil.

16. Assuming the total present annual *catches* of oil sardine on the West Coast to be 100,000 tons, which is probable enough from data in my possession, the obtainable oil at only 10 per cent of the green weight (allowing for food consumption and for months in which oil is small and very small in quantity) would be 10,000 tons, value Rs. 16 lakhs, now *practically thrown away* except that portion which is consumed as food in the fresh fish; add, say, 15,000 tons of guano worth 10 lakhs, and it will be seen that a considerable business is developing and one well worth the attention of middlemen who will promote small factories and buy up their produce. A single Ceylon merchant states that he will take 5,000 tons of guano per annum, and the market for oil is unlimited and clamorous for oil, for the paint and colour trade, for jute batching, leather working, soap making, steel tempering, and other industries. The receipt of above 40 letters from the trade in Great Britain and Europe in general, following on a small paragraph in the Board of Trade Journal, shows the readiness of the market for oil. It is to be remembered that the catches can be largely increased if there is an effective demand for the fish.

17. *Fishing boats.*—The fishing boat "Sutherland," built for work on the East Coast, was tried at Cannanore during the season, but proved much too slow for the light winds of the West Coast fishing season; the experience of this season confirms that of last, viz., that the Ratnagiri boats are the best for the West Coast. There were also difficulties as regards crew, over whom supervision could not be maintained in the absence of a reliable master who would skipper the boat; this is impossible on so small a boat. The boat is too big for small work and not nearly big enough for large work. She was accordingly sent to Tuticorin for other work.

18. The "Turbinella," motor fishing boat, nearly twice the tonnage of the "Sutherland" and having a

15 horse-power Dan engine, was lent to the Pearl and Chank Department at Tuticorin for use in the absence of a survey and dredging boat. She occasionally fished, however, and though her nets were very small and insufficient, she attracted attention by catching seer in fair quantities in her nets, a result never before seen at Tuticorin, insomuch that the fishermen borrowed her nets on a quarter-share basis, and attempted to use them; owing, however, to the feebleness of their boats the result was disappointing.

19. The prices obtained by auction for the station fish were higher than those of ordinary cures; for fish supplied to the jails and for the few outside parcels, I found that after charging for salt, labour, etc., at considerably higher rates than those obtaining in the local trade, a charge of 50 per cent on the cost of fresh fish gave, as a rule, a 20 per cent profit, e.g., I paid the Ratnagiri boats on contract Rs. 10 per 100 for fresh fish and charged Rs. 15 for the cured fish, this was considerably higher than local rates which were about Rs. 13–8–0. I found, in fact, that by fixing Rs. 15 as my reserve price at auctions, I was unable to sell any except prime parcels. Since 20 per cent is the profit on a transaction in which capital was turned over in a few days or so and not once in a year, it is a high rate; probably the local trade is content with 10 per cent on the transaction which, with them, lasts but a week; Rs. 13 to Rs. 13–8–0 cannot give much more than a ten per cent profit. I note, from recent trade journals, that the wholesale fish merchants in the United States of America are content with or obtain profits cut very fine; "fish, for instance, are handled by the big New York fishermen at a profit of one-quarter cent (1½ pies or a half farthing) a pound," or 4 per cent if the wholesale price is only 6 cents per pound.

Dried and gutted sardines were sold at about Rs. 85 to 90 per ton, or less than 8 pies per lb. of dry food. As explained in paragraph 14 *supra* the whole of this was clear gain in cases where the expenses were paid by the oil and guano derived from the guts of the *same* individual fish. But even putting aside oil and guano, a rate of Rs. 93 (8 pies per lb. of dry gutted fish) gives good profit, e.g., five tons of small sardine, when

oil is in small quantity, gut and dry into something over one ton of marketable fish, or 270,000 at 54,000 per ton. These five tons cost at most Rs. 55, gutting (Rs. 7-8-0), salt (for $2\frac{1}{2}$ tons, at 1 to 8, Rs. 6-8-0) and labour for drying and storing (Rs. 5), cost Rs. 19, cost of packing 21 or 22 cwt. in date-mat parcels of one hundred weight each, is Rs. 6; total cost Rs. 80. This weight will readily sell for Rs. 96, giving a profit of Rs. 16, or 20 per cent on Rs. 80. If a rate of nine pies (three-fourths anna) per lb. is charged or Rs. 105 per ton, the profit is very heavy, especially as the whole transaction, from catch to sale, need occupy only a week or less. At this moment (July) ordinary native-cured dried sardines are selling at Cannanore at Rs. 125 per ton, so that curers who can hold over a stock and keep it in good order, earn large profits. To the price obtained for the fish must be added the value of something over $2\frac{1}{2}$ tons of guts, available as manure; these will dry into something less than one ton, worth Rs. 25 per ton at only 2 per cent nitrogen and 10 per cent, phosphoric acid. These guts, with or without oil, have been generally neglected hitherto in considering profits; in the villages they are, or till lately have been, mostly thrown away; at certain seasons they are used, to some extent, for tobacco, cocoanut trees and cucumber crops, but as a rule they are largely wasted, and always contain at least 30 per cent of sand; when sold they fetch, at most, one anna per basket containing about an Indian maund. The proper utilisation of offal has already been the subject of experiment, but required much more attention both as an item of immediate profit to the curers, and a general economic benefit.

20. Reading the above with the report of last year, it is clear that there is good profit in the fish trade if properly organized so as to sell really superior products at a price very slightly above the price of the ordinary cured fish to the immense potential market of people willing to pay such slightly higher price for a good article. Such fish cannot compete *in price* with the native-cured fish in which, for instance, in mackerel Rs. 3 per 1,000 when fresh, they are sold *cured* at Rs. 4 to Rs. 4-2-0 which includes the cost of all labour, salt, and profit, while a superior article cannot be sold under Rs. 4-8-0, though at Rs. 4-12-0 to Rs. 5 there is a good

profit ; at Rs. 4–8–0 per 1,000 fresh fish, Rs. 6–8–0 for dried fish should be a full, and Rs. 7 a high price. But native-cured fish is apt to be tainted, is certainly produced under less sanitary and cleanly conditions than station fish, and, in any case, the salt used is the unwashed Government salt containing a good deal of sand and mud, so that the article is necessarily somewhat gritty. In the supply to jails where the consumers live in abnormal conditions, it is well to be certain that the fish supplied is thoroughly wholesome and prepared under the best conditions.

21. The experience of the year confirms the views indicated in paragraphs 18 and 19 of my last year's report, viz., the necessity for exploiting the potential better-class market if the fishery industry and trade as a whole are to be developed and faulty methods and goods eliminated. The difference between the cost of ordinary karuvād (dried salt fish) and of similar fish cured in a far better and more sanitary manner, is much less than one pie per pound ; e.g., mackerel costing ordinarily Rupees 4–2–0 or Rs. 4–4–0 per 1,000 dried fish weighing 120 lb. may cost Rs. 4–8–0 when cured by better methods, viz., one anna extra for clean and pure salt, two annas for extra labour, one anna for interest, etc., on respectable, sanitary plant ; this extra four annas means only the difference between 6·8 and 7·2 pies (0·4 pies per lb.) ; 100 varian (small seer) weighing dry, say, 130 lb., cost, say, Rs. 12 and Rs. 12–8–0, respectively, the extra cost meaning a difference of three-quarters of a pie on about As. 1–6 per lb. But this extra half or three-quarters pie means a very great difference in the class of goods, and if the difference is made up to one pie by attractive packing, there can be no doubt but that such goods would find an immense market in tens of thousands of respectable households where ordinary karuvād is taboo because of its bad appearance, "high" flavour, and faulty food character. Since, by a wellknown rule, the additional cost would be more than recouped by the sellers, the extra profit, in addition to the greatly increased market, would induce the curers to follow the improved rather than the traditional methods ; without such market, ready and anxious to pay a slightly higher price for a much better article, the ancient methods, sufficing the ancient markets, will continue. In other

words the development of the market must synchronize with the development of method.

22. Nothing much was done this year in ascertaining the conditions and tastes of the various markets, except that, as above stated, three jails were supplied with the specific purposes of ascertaining the character of the supply required, and of popularizing, e.g., amongst the warders and others, articles somewhat superior to the ordinary beach of fish-curing yard article. This small branch of the trade has now been actually created, and it is open for others to take it up. Correspondence was opened by a firm in Hongkong in view to purchase for the Chinese market, and a large sample was sent; the result was not very satisfactory as the station produce had not the strong *high* flavour of the articles demanded by Chinese taste as witnessed by specimens received from Hongkong. Parcels were also bought by a Rangoon merchant, but without a proper business organization it is not desirable to enter distant markets especially when the Indian market is at our doors. Rangoon prices, however, are good and are well worth the attention of the regular trade.

In the matter of oil and guano a good deal has been done not merely in fostering the new methods, but in ascertaining markets. But while the output is so small, it is difficult to get hold of really good markets at good prices; e.g., a large British firm will not look at a parcel of oil of less than, perhaps, 250 tons (as per letters actually received), and it is difficult for producers of 10, 20, or even 50 tons *per annum* to get into touch with such a demand. The shortsighted and jealous idea of the few present manufacturers is to keep others from entering the business, whereas it is only when a hundred small factories are at work that the business will be worth the attention of the large dealers; without plenty of produce there will be little or no competition by buyers, and manufacturers will have to take low prices. When the total coast produce is 100 tons, it is hardly worth the consideration or time of respectable firms; when it gets to 1,000 tons there will be competition by purchasers, and the manufacturers will get full market prices. It is to be remembered that the world market, and even that of India, is practically unlimited owing to the vast demands of the numerous industries, so that

prices cannot be in the least affected by the addition of one or two thousand tons *per annum*, or even of five thousand; hence the entry of even a hundred small manufacturers into the business cannot lower prices but must improve them for the local manufacturer by bringing in the purchasing competition of larger markets and buyers. Hence the department has worked to induce (1) an extended manufacture, (2) the entry of reputable firms as promoters of these small factories and as buyers; also to foster the idea of *co-operation* rather than of jealousy amongst the manufacturers, so that they may be able to combine their several outputs and place on the market large parcels of uniform and steady quality worth the attention of the big purchasing firms. The Agricultural department has also approved highly of the new fish guano and is likely to push its use, by example and precept, among our ryots. It may here be usefully mentioned that specimens were obtained of the fish oil used by 11 jute mills in Calcutta; the oil appears very similar to our ordinary brown oil, but while the latter costs Rs. 6 per Indian maund or about Rs. 8 free of stearine, the prices for the oil in use were Rs. 8-8-0 to Rs. 14 per maund; hence there appears to be a huge market in Calcutta for our oils. The demand of a leather factory for fine oil has been mentioned in paragraph 13.

Pisciculture.

23. *Marine pisciculture.*—A notable experiment was begun during the year in oyster-culture based upon Mr. Hornell's enquiry in 1909 at Arcachon. In the two previous years' reports the extraordinarily rapid development of the oyster in the experimental bed at Ennore was noticed. Hence a small culture farm, on the Arcachon pattern, was laid down at Pulicat which, in 1908, was ascertained to have suitable localities. Several thousand limed tiles were laid down in October and November in a duly prepared area and a good spat fall obtained; the growth was as phenomenal as at Ennore, the largest specimens having attained a size of $2\frac{3}{10}$ by $2\frac{3}{10}$ inches in eight to ten weeks (!) with an approximate mean of $1\frac{1}{8}$ by $1\frac{1}{8}$ inches. Mr. Hornell considered that the oysters will be fully mature and marketable by June 1912 when he estimates that, if nothing unusually

untoward happens, 15,000 dozen, allowing for ordinary wastage, may be ready for consumption. Not only so, but he is inclined to believe in two spat falls in the year; this seems to be correct since a fresh set of tiles laid down this June have already (July) a quantity of young oysters; hence the oyster industry should become a most profitable and successful one both for the fresh oyster trade and, more especially, for the canning, dried oyster, and oyster-extract business. Quantities of brood mussels also settled on the tiles so that the development of an industry in this edible may also be expected.

Mr. Hornell also drew up during the year a report on marine fish-farming in France and Italy, with suggestions for Madras practice; this report has since been submitted to Government.

24. *Inland pisciculture and conservancy.*—The introduction of New Zealand trout to Nilgiri waters was successfully accomplished by Mr. Wilson in November of the previous year, but the growth during the year under report was so considerable and successful that fishing is to begin in the current year 1911. Mr. Wilson reports extraordinary trout growth, e.g., a 15 months old trout (S. irideus) 15 inches long and 8¼ inches round the broadest part; it was also sexually mature; many others were of nearly similar size. In November 1910, moreover, Mr. Wilson introduced ova of wild brown trout (Salmo fario) at his own charge from his hatchery in England, and these were successfully hatched and planted out; these trout operations however will be reported on by the Collector of the Nilgiris. Low country operations were confined (*a*) to pushing on the construction of the Sunkesula (Kurnool canal) fish farm; (*b*) the stocking of the Daroji and Barur tanks with carp, etc.; (*c*) the planning of a scheme for stocking the new reservoir or lake under construction for the Salem town water-supply, and the preparation of items of plant for the same; the reservoir is not yet ready; (*d*) the investigation of and drawing up a complete scheme and plans for a fish farm to supply the Kanigiri and other Nellore tanks, or rather storage reservoirs, with good fish; this was a matter of much labour, but the project is now ready for submission to Government. The project for hatching hilsa has, for

the present, been held in abeyance; it presents great practical difficulties, and it was deemed advisable to concentrate effort on the fish farms. Mr. Wilson also inspected pisciculturally a variety of large tanks and canals, and is assisting the Darjiling municipality by his advice and plans in the matter of trout hatching and culture.

The conservancy of the upper waters of the Moyār and Bhavāni was maintained; this also is under the Collector of the Nilgiris, but Mr. Wilson reports his opinion that much has already resulted in the increase of the head of fish. Mr. Wilson also succeeded in 1910 in preventing the hot weather drive and dynamiting of the fish in the Cauvery below Hogenkal—a practice which was wasteful and destructive, as well as illegal so far as the use of dynamite is concerned.

Pearl and Chank Fisheries.

25. These will, as usual, be reported on separately. The current season was fairly good, and the shells fished closely approximated to last year's catch; the sale of the shells has been effected at a rate somewhat lower than last year, but much higher than in previous years. The motor-boat "Pearl" again did excellent work in towing canoes in periods of calm (thirty days) to and from the several diving grounds, and 43,375 shells, which should yield a net profit to Government of from Rs. 2,500 to Rs. 3,000, were in consequence fished which would otherwise not have been taken; since the total cost of the boat, when at work, for crew, fuel, stores, etc., is less than Rs. 100 per month, her employment has yielded a large net profit to Government. Experience shows, however, that the boat is not quite powerful or large enough for her work and a fresh arrangement is in contemplation. The motor fishing boat "Turbinella" was used in this service, and by her aid Mr. Hornell examined 34 of the pearl banks, with entirely negative results; the boat is, however, much too small for continuous work and a vast area remains to be inspected both of the ordinary banks and of ground hitherto neglected but potentially oyster bearing. New plans and estimates were worked out during the year for the proposed auxiliary inspection schooner intended to take the place of the old "Margarita" which

was sold last year, and to serve also for general work by "Fisheries." These were sent to Government and thence to the Indian Marine Department where the matter at present rests; the want of a good vessel is much felt.

Mr. Hornell made a very important visit to Calcutta, Dacca, etc., to enquire into the conditions and methods of the chank trade and industry; he has embodied the results in a trade report on which action has been based, while a second, dealing with the shell-cutting industry, has been prepared.

Co-operation.

26. During the lengthy tour of my Assistant, Mr. Govindan, up and down the West Coast he paid attention, *inter alia*, to the important question of co-operation among the fishermen and curers. He found the germs of such co-operation in an existing society in Mangalore started in 1907 and working on rules more or less of their own but apparently on true co-operative lines, while in other places he found a ready acquiescence in the idea on which he frequently spoke and lectured; at Tānūr, where, as I mentioned in my very first report (1906), the fishermen and curers are a series of independent and isolated units,—but, for that very reason, subject to heavy usury on their necessary loans—there appears to be an excellent field for co-operative work; this will be specially attended to next season as there will be a branch station at Tānūr.

The Mangalore society resulted in 1907 from the perusal by a District Press clerk of the rules, etc., for co-operative societies published in the District Gazette; at present the society is not registered, and worked solely on the monthly subscriptions, etc., of its 51 members; the loans, however, are granted by the committee—not by auction as in the nidhis—and the committee members are reported to satisfy themselves of the necessity for each loan, e.g., by examining the fishing boat to be repaired, etc., before granting it. So far the society is working satisfactorily. Another interesting society is an indigenous temperance society; the besetting vice of the fishing classes is drink, partly by reason of their onerous and exposed calling, partly because they have hitherto had no opportunities for thrift or for the

productive use of their money or credit, and therefore readily got rid of any surplus cash. The temperance society is one of *young* men, and strange and sad to say, the most bitter opponents of their resolution are said to be the parents, including the mothers ; temperance is a departure from hereditary custom and all departures from custom are, in their eyes, bad.

Apart from general economic, social, and moral considerations, there is peculiar need on the West Coast for co-operation, since the development of the fishing industry in general depends upon the syndication of men and capital, while, as the season under report has shown, in the new guano and oil industry it is of the greatest importance to unite co-operatively a number of small manufacturers who will combine their small parcels of produce and place them on the market in large parcels ; this will be for the benefit of both manufacturer, middlemen, and consumer.

I hope to see much propagandist work done during the next few years, especially by the aid of my Assistant Mr. V. Govindan, who, himself a West Coast man, adds devotion to knowledge and experience, and enjoys the confidence of the people.

General.

27. A notable visit of enquiry was that of an official deputation from Eastern Bengal and Assam to study our methods. The student from Travancore mentioned last year again spent the season at the station and has now returned to Travancore intending to take up the business, especially that of oil and guano. An exhibit of the experimental station products, viz., dried salt fish, smoked fish, and oil and guano, was sent to the Allahabad Exhibition and earned a gold medal. The bulletins of the department were issued to about 150 of the scientific societies and fishery institutions of the world, and in exchange the department is receiving numerous valuable publications. Mr. Hornell has also issued biological specimens to various institutions and persons such as the British Museum and Indian Museum, but his ability to do so is very limited owing to the entire want of a biological station or laboratory.

In repeating the second part of paragraph 24 of the report for 1909–1910 I may call special attention to the

nitial success of the new oil and guano industry, the development of which in the immediate future, seems assured ; here success seems to be due to several factors, such as,. (1) the obvious profit, (2) the *visible* ease and simplicity of the process, (3) the occasional existence of a rudimentary process of oil extraction, especially in South Malabar and as a cottage industry near Mangalore, (4) the assured market, which depends upon an existing and effective external demand and not upon internal questions of custom, taste, and organization of retail trade as is the case with edible goods of a quality or preparation novel to the country.

In this latter case it is just the organization that is the difficult matter, and this is precisely where a Government department can help but little—however altruistically anxious—without running up against opposition often more sentimental or groundless than valid. As regards oil and guano it is wholly the action of Government that has initiated the new industry of which the propaganda began in 1907 but more particularly in 1908 and it is gratifying to remember that the industry means, *at its lowest*, the conservation and utilization of oil, hitherto wasted or, rather, *destroyed* in beach drying the oil-sardine for manure, and that this conservation means an economic benefit in the early future amounting in mere money to many lakhs of rupees, in addition to many collateral benefits, such as the industrial and commercial stimulation afforded by the trade, and the readiness and ease with which the new light weight guano, unadulterated with sand, can be transported to and assimilated by the crops of the country.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., Honorary Director of Fisheries.

Dated—the 25th June 1912.

I have the honour to submit my annual report on the operations of the Fishery office from 1st April 1911 to 31st March 1912.

2. *Experimental stations.*—These were at work in Calicut and Tānūr. As proposed in my letter No. Ref. 34, dated 27th January 1911, I moved the work of preparing sardine oil and guano from Cannanore, where fish were not very abundant and private work in the oil and guano business is well started, to Tānūr where fish are ordinarily far more abundant; this necessitated moving other curing operations also as it was impossible for me to supervise work at two distant points. Tānūr, near Calicut, has more fishing boats than any other fishery centre in Malabar and lands a much greater weight of fish; 8 acres of sandy beach were secured by the courtesy of the Revenue Department, and a good fishery station is gradually being formed there; several hundred cocoanuts have been planted and are thriving, and when fully planted, the income from the trees should pay for the subordinate staff of the station.

3. *Light curing* was advanced; fish can now be brought into the yard between 7 and 8 A.M., cleaned, brined or salted for 20 to 30 minutes (or even less), sufficiently dried, packed, and despatched by noon on rail and such fish will keep good for several days; the fish is but slightly saline and when soaked is practically fresh; parcels were repeatedly sent to Kodaikanal—three or four days in transit—and arrived in good condition. Such fish is, of course, not fresh fish, but is a very fair substitute for it, and, being only slightly salted, has the advantages of having lost but little of its nutritive value and of its digestibility. When such fish are smoked for a few hours their keeping capacity is much enhanced and, to Europeans at all events, the flavour greatly improved; these smoked fish are, by many consumers, much preferred to anything of this class that can be imported, since imported fish may become insipid by canning or by the voyage.

4. Light salted fish were also fully dried; it was found that, using perfect cleanliness, fish need be kept in salt for much less than one hour, and can then be dried, by

solar or artificial heat, without the slightest appearance of taint; this not only saves the time usually spent in salting, but keeps the product far more nutritious and digestible.

5. By a similar method curing of sardines for food was greatly improved; the whole, ungutted sardine, just as it comes from the sea, is washed, thrown into saturated brine—kept saturated by additions of salt—or mixed with dry salt at the rate of 1 lb. salt to six or seven of fish; the fish are kept in salt or brine only for one to two hours (according to size and fatness) and are then sun-dried; the product is thoroughly good, well-flavoured, and keeps for months; it is the quickest, easiest, and most productive of good food of any process yet adopted, and enables these fish to be dealt with by tons per hour, and turned rapidly into sound but cheap food instead of being dried on the beach into very inferior manure. When such fish are salted dry, that is by rousing with one to six salt as above, it is found that three-fifths of the salt is recovered, being undissolved, when the fish is washed out of the salt; this surplus salt is used for the next batch. Hence the salt actually expended is only about one to twelve or less, a low rate; excess of salt is necessary for each batch so that the action may be prompt and that each fish be in thorough contact with the salt.

6. Successful experiments were made in artificial drying by using a low combustion stove and a hand-driven fan in order to secure drying when weather conditions are unfavourable or to ensure rapidity or control. They will be continued this year with better plant as the method gives much promise especially for cloudy and rainy weather.

7. Experiments in drying fish by means of a vacuum plant have temporarily failed owing to a defect which prevented my obtaining a sufficiently high vacuum for evaporation at a low temperature, but the method promises success with advantages which will be detailed when success has been obtained; present enquiries at home will probably solve the difficulty.

8. For light cured fish, which are more readily attacked by flies than heavily salted fish, a fly proof shed was put up; such sheds are not costly, and as the fish are hung in many tiers, the method is very economical of space—so often deficient in crowded yards—

while they are wholly protected from the dangers of fly-infection.

9. *Pickling.*—Both mackerel and sardines have been very successfully pickled, that is, packed wet in air-tight barrels with plenty of salt, and kept moist; this pickled fish may either be sent out in the original barrels, or removed from the barrels, drained but not dried, and packed moist with a little extra salt in boxes or kerosine tins. Instead of barrels, kerosine tins have been successfully used. The advantages of fish cured by this method as compared with dried fish are its greater digestibility, its ready preservation for many months if the containers are kept air-tight, the comparative ease with which the salt may be removed, by soaking, from wet fish, and a greater range of culinary possibilities; such fish can also at any time be de-salted and cured by smoking. Moreover, there is much saving in labour since the fish are packed away in their containers as fast as they are cleaned and, if necessary, split; the two days' labour of spreading and drying in the sun is obviated; the fish, too, are removed from all danger of taint as soon as they are in the barrels, and are not liable to the attacks of insects, mildew, etc., which trouble dried fish especially when stored in bulk, and which necessitate constant re-drying and re-storing. Sardines, moreover, may be at once packed whole, without gutting, with a minimum, therefore, of delay. Finally, wet curing is independent of weather, and can as readily be conducted in cloudy and rainy weather as in the dry season. All the above points have been demonstrated by frequent experiments; the disadvantages, as compared with sun-dried fish, are the need for somewhat expensive containers, expensive that is for poor people even if only kerosine tins, the larger quantity of salt required, and the weight of the packages of wet fish and consequent cost of transport.

10. *Canning.*—This branch was opened at Calicut during the season with plant obtained some time previously. The small *can-making* plant was supplemented by several small items needed for practical work and very good sardine tins of the usual "quarter" and "half" sizes are now readily made; also round tins of any depth, but of one diameter only. Our tins usually contain a somewhat greater—sometimes a considerably

greater—weight of fish than those sold as quarters or halves in the European trade.

The *canning* plant in use consists entirely of locally-made articles except the processing (cooking or sterilising) kettles which are small autoclaves obtained from Europe, that is strong vessels in which the cans are heated by pressure steam—usually about 12-lb. steam—generated within the vessels themselves by powerful lamps or fire applied externally; this gives a temperature of over 240° F. sufficient to sterilise all fish produce.

11. Mackerel, sardines and prawns have chiefly been canned, and with encouraging success for a first season; in some experiments the success has been marked and even complete but in others only partial; the goods have continuously been examined, tested and tasted. Insuccess has chiefly been due to (*a*) the inferior oils obtainable in India; inferior, that is, for canning purposes; (*b*) to inexperience in condimental additions; (*c*) to inappropriate methods or periods of salting, drying, or cooking; (*d*) to the inexperience of the soldering staff in hermetically and rapidly sealing tins full of oil, brine, etc. Many of the difficulties will probably be surmounted by the enquiries now being made in Great Britain, etc.; all will gradually yield to experience. But general success has already been sufficient to warrant the expectation of teaching students and the publication of methods and recipes, by the end of next season, even though the products do not attain the excellence begotten of many years' experience. In a former report allusion was made to the fact that even in the United States several years of experiment by the experts of that inventive and highly-educated country were admittedly needed before the canning of their "sardines" was successful; the present advertisement of a well-known British brand states that ten years were given to the perfecting of that single brand, hence success in general canning cannot at once be obtained in India with many new conditions to face. The last season's experience has both trained the staff and indicated our probable methods and recipes, our mistakes and difficulties; it only remains to win through.

12. It has, so far, been found impossible to procure a trained canning expert, none is available at Mahē and M. Josselin, the French canning expert of that place,

died last October; enquiries at Goa were equally unsuccessful. But the services of men who have worked in the Mahē Factory and are acquainted with the mechanical part of the business, were secured, and my personal knowledge and attention have been mainly devoted to this part of our season's experimental work. After all, little but experience and close attention to details are needed, provided one is thoroughly acquainted with the principles, necessities, and general methods of canning, nor would any expert, even from Europe, that we could possibly afford, be likely to succeed without much experiment in details, owing to the difference in material and conditions; indeed, a highly-educated European expert, versed equally in the principles of canning and its technique, and able from those reasons, to adapt his methods to new materials and conditions, would hardly be attainable at any pay, while a mere foreman would, by himself, be of little value under circumstances wholly opposed to his rule-of-thumb knowledge. In every country, even in Japan, men have had in such matters to win through by intelligent, continuous experiment, and we can do and are doing the same at Calicut.

13. *Fish pastes.*—Another item of work at the cannery has been the preparation and canning of pure, unadulterated fish pastes, chiefly mackerel and prawn. Here there has been marked success, and the future experiments relate mainly to market questions such as the provision of good materials at moderate rates, the flavourings most suited to Indian tastes, the obtaining of suitable tins and other containers (e.g., earthenware) properly decorated, etc. The method enables a manufacturer to place most wholesome, nutritious, and palatable food on the markets in a concentrated form; though seemingly expensive the goods are really cheap since every particle is pure, nutritious food, of which a two-ounce tin contains as much as a fish of considerable size; transport charges are reduced to a minimum, and the product, when canned will keep good for years. Effort has chiefly been directed to the production of plain but palatable paste, i.e., concentrated fish, intended for general consumption at low prices, and not to "Delikatessen" for luxurious tables, though these have not been neglected. By the end of next season the station will be prepared to train students and publish its recipes.

14. *Sardine oil and guano.*—These products formed the main feature in last year's report; this year there is little to record from the Tānūr Experimental Station owing mainly to the absence of shoals, but partly to delay in the arrival and setting up of new, and in the transfer of old, plant. A powerful English press capable of taking charges of half a ton has been set up, and also a steam-driven centrifugal; the latter was used but once and proved very successful in separating fluids from the solid. Steam has also been applied to boiling the mass in the boiling vats, so as to obtain a prime, light-coloured oil, and to reduce the boiling period; the preliminary experiments promise complete success. A small steam oil-boiling pan for sterilising the oil and driving off any suspended water has also been set up. The whole of the above can be run by a single boiler of 4 N.H.P., but two are available, since the boiler eventually intended for the cannery is on hand. A small oil filter press, and a steam oil refining pan, working with an air blast, are also on hand for future experiments, while a large filter press was obtained second hand from the Medical Stores Department, Madras. Next season will be devoted to experiments, with the above plant.

Mr. Govindan continued his lectures and practical demonstrations—with a small portable plant—on the coast and has frequently had to tour in order to advise persons who had set up or intended to set up the small plant which we advocate. We have also reported on several occasions to the Collectors of the two West Coast districts, on applications made to them for land for factories.

15. Meanwhile the industry has got on in unusual fashion. In 1909 there were but two little factories, viz., that of the experimental station, Cannanore, and that of Mr. Ooni Choyi also of Cannanore, our first convert to the new method. In the season 1910-11, nine small factories were running and many more were being prepared or projected; the season 1911-12 opened with no less than forty-five small factories in Malabar and South Kanara, and European firms are taking interest in the business and in the products. Moreover, other factories are probable in Cochin and Travancore. The business has come to stay, and should be highly profitable to producers and of great economic advantage.

These small factories at present wisely limit themselves to—and indeed the plant in use is only calculated for—the production of crude brown oil; in fact, the nearest large market, viz., the jute industry in Calcutta, prefers this class of oil and does not desire the removal of the stearine. Hence owing to the development of the local industry, the experimental station has nothing further to do in the matter of the crude brown oil. But there is an immense and better-priced market for finer oils, especially if refined and deodorized, and the station has consequently adapted its plant, as mentioned above, to secure only light-coloured oil, to separate the oil and stearine by means of a filter press, and to refine the oil; a special laboratory plant for experiments in deodorizing has also been personally obtained, while enquiries now being made in England are expected to give material help. Some of the best oil has been supplied gratis to local medical men, who have used it internally in various cases and who consider it probably a useful substitute for other oils, but this is a matter on which the station can give no opinion, save that the oil is far less unpalatable than some country oils. The better class oil is in demand for leather factories, e.g., in Cawnpore, and for paint and colour works: medicinally there may be a field for its use, and, if thorough deodorization is possible, it will be edibly useful.

16. *Pisciculture—Fresh water.*—This is the special province of our piscicultural expert, Mr. H. C. Wilson. His skilful work on the Nilgiris has resulted in the complete establishment of trout (chiefly S. Irideus but partly S. fario) in the higher waters; the fisheries were opened to anglers about the end of August 1911 and many fish, the largest weighing 5½ lb., were taken. The head of fish now in the waters is large and valuable, while the license fees were considerable although the fishing was opened near the end of the season.

17. The conservation of the upper waters of the Moyār and Bhavāni was continued and Mr. Wilson reports very perceptible improvement in the stock of fish since illegal practices (use of fixed engines, dynamiting, etc.) were checked. These illegalities were largely the work of gangs of men who come up for the purpose, not of the local tribes. This work and that of stocking the Nilgiri waters with trout are under the Collector of

the Nilgiris, who reports thereon, but are mentioned here since they were carried out by Mr. Wilson of this department.

18. On the plains valuable and hitherto unique work was done by Mr. Wilson ; the Sunkesula (Kurnool) fish-farm was brought to practical completion as the breeding arrangements, stock and fry ponds were in regular use ; it now contains a fine stock of thousands of fish, carp of all species being chiefly represented, and murrel (ophiocephalids) which grow well and are greatly in demand. It will now be possible to begin stocking the canal and other waters which was the primary object of the farm. But the stock is so large and grows so rapidly that it is necessary to thin out the big fish, and since the neighbouring town of Kurnool itself provides a large and exigent market, to say nothing of the district, Mr. Wilson has, in communication with the municipal authorities, drawn up plans for marketing his surplus fish. This is a very important development of the work ; no such idea as that of breeding and nurturing fish for the urban market had been dreamed of, and Mr. Wilson's work now shows that there is an open and easily-worked field for a new industry. Since a single large murrel, easily bred, very nutritious, and with proper attention to desirable flavour, can be sold for a rupee, there is obviously an opening for the commercial breeding of fish wherever there is water and market ; and since murrel of all fish are most easily transported, and live a long time out of water, they are specially excellent for market purposes.

19. The farm gives complete opportunities for studying the bionomics of our Madras fresh-water fish, so that the fish yielding the best class of food, the most rapid growers, etc., can be selected for propagation and distribution. The methods of hatching, rearing, and transport suitable to tropical conditions and the nature of the various species of fish are being devised, and piscicultural science on both its pure and practical sides is being studied. One interesting study was that of the murrel (Ophioceph. punctatus) the eggs of which are now known to be floating and not demersal as hitherto stated; these fish nest and protect their young in broods till of the fingerling size ; hence it is easy to capture them for farm purposes.

20. One result of the study of the murrel is the scheme which, during the year, Mr. Wilson developed for a second fish farm in the Colair lake, in which the breeding of murrel will be an important item. The second fish farm is equally designed to breed hilsa in view (*a*) to increasing the numbers of this excellent fish in the Kistna and Gōdāvari rivers both of which will be served by a floating establishment in the Colair lake, (*b*) to provide ova for stocking the West Coast rivers which appear admirably adapted for this anadromous fish, being uninterrupted by anicuts, full of fish food, and having excellent breeding grounds. In this connection may be mentioned the fact that two years ago a trial consignment of hilsa ova was placed by Mr. Wilson in the Ponnani river, and that in November last a two year old hilsa was caught in the estuary of that river, the first hilsa known to have been caught on the Malabar coast ; this gives support to the belief that the rivers on that coast are suitable for the development of this fine and commercially valuable fish.

The Colair hilsa breeding scheme replaces that originally proposed on the Coleroon which Mr. Wilson has found a quite unsuitable locality for the artificial propagation of hilsa, partly by reason of the ignorant hostility of the fishermen, partly because of the unsuitableness of the locality for unhampered experiment, partly because of the impracticability of obtaining a nursery area or growing ground. The Colair lake seems to provide all necessary advantages.

21. Other important piscicultural work carried out by Mr. Wilson was the stocking of several large tanks, the preparation of plant for the Salem Waterworks Reservoir, etc. On the visit of Mr. Howell of the Punjab to Sunkesula and by subsequent correspondence Mr. Wilson was able to place at Mr. Howell's disposal such of the information, methods, plant, etc., which had been accumulated or developed in Mr. Wilson's four years' work in Madras, as appeared likely to be of service in the Punjab. Mr. Wilson made numerous tours and part of his time was occupied in selecting a new site for the proposed Kanigiri (Nellore) fish farm, a very promising project, the originally proposed site for which had to be disallowed by the Public Works Department for departmental reasons ; a new site is now under report.

22. *Marine pisciculture.*—This is necessarily of newer date than inland work, and is entirely due to and was carried out by Mr. James Hornell, as Marine Assistant. The experiment in *oyster culture* at Pulicat, mentioned in last year's report and based on small experiments at Ennore and Mr. Hornell's visit to Arcachon, was successfully continued; Mr. Hornell has been able greatly to simplify and economise on the methods, etc., used at first starting, and notwithstanding vicissitudes, due mainly to the excessively low water of the lake by reason of drought, he expects this midsummer, a fine batch of mature cultivated oysters, that is within 21 months from spat-fall to maturity; thenceforward increasing quantities will be periodically available. The experience gained already has been found useful in connection with the scheme for oyster conservation and replenishment at Karachi about which Mr. Hornell was originally, and continues from time to time to be, consulted; it will of course immensely help ourselves in future experiments and in educational work. The further difficulties are those of marketing the produce either raw or otherwise.

23. *Fish-farming* was also taken up: Mr. Hornell made several tours of general enquiry and found many places on both coasts suitable for fish-farming, especially in Ganjām where, in fact, a respectable person was induced to take up on a very promising site and on lines indicated by Mr. Hornell, a small experiment. A capital site for the departmental fish farm was, however, selected at Tuticorin close to the chank godowns since this is Mr. Hornell's head-quarters as Superintendent of Pearl and Chank Fisheries, and we have there a staff capable of working on Mr. Hornell's instructions; the detailed scheme was drawn up during the year and has been sanctioned by Government. In this farm fish, oysters, pearl oysters, chanks, etc., will be grown and their bionomics and suitability for growth in captivity, carefully studied, to the probable great advantage of commercial piscicultural work; the proximity of the Tuticorin market will also demonstrate the business value of lagoon fish-farming. Certain very important and probably lucrative researches will also now be possible as regards the breeding of chanks and the development of pearls in the pearl oyster.

24. *Pearl and Chank Fisheries.*—These will, as usual, be separately reported on in detail ; only an abstract follows. Mr. Hornell continued as Superintendent of these fisheries with J. A. Fernandez as his Sub-Assistant.

Nothing was possible in the matter of pearl fisheries except such inspections, chiefly by means of dredging, as were possible with the "Turbinella" ; no pearl oysters are yet visible, but Mr. Hornell believes that the conditions are favourable for a spat-fall, and he obtained the sanction of Government for a small and new experiment in protecting a batch of oysters should they appear, in view not only to provide a breeding reserve but to test the possibility of doing this on a large scale.

Mr. Hornell also carried out investigations upon the anatomy and identity of certain fish-parasites, a subject intimately connected with the problem of pearl production ; an account of three new species which were found and of a new genus which had to be created for one of these, has been published under the title of *New Cestodes from Indian Fishes* in the "Records of the Indian Museum" for 1912.

25. The chank fisheries of the previous season were sold during the year on a novel method, viz., a three-year contract. For one reason or other the regular contractors declined to make any bids for the shells though of very good quality and ready-sorted by the department into the nine grades recognised by the trade, so that buyers know exactly what was on offer. Eventually the Superintendent negotiated a three-year lease on favourable terms with a new contractor from Dacca who faithfully redeemed his contract and will accordingly take all the shells for the current and next year's fishery ; this relieves us of much annual worry and is good business for the contractor.

The current season's catches have been unusually deficient, chiefly owing to a long period of disturbed weather which discouraged or debarred men already only too ready to seek other less difficult work, as for instance, in Tuticorin harbour or on the Pamban railway. In view of the probable decrease of divers, whose sons do not seem likely to follow their ancestral business, the Superintendent proposed and Government sanctioned the hiring of a couple of crews of Arabs from the Persian Gulf, but it was not possible to get them for the current

season. Mr. Hornell also considers that mechanical dredging will shortly have to be relied on to keep up our takes, for which purpose the new schooner will be invaluable. The neglected fishery of South Arcot is now proving profitable and the lease has been sold for three years at a rate more than double that of the first year; the new fishery at Idinthakarai in the south of the Tinnevelly district opened only last year, also doubled its small output, and gives promise of development.

26. The Superintendent as a result of the visit to Dacca, etc., has already submitted a practical report on the chank business; during the year he collected much information for a further report on the chank industry in its technical, economic and ethnological aspects. It is most interesting to hear that in visiting the sites of the ancient cities of Korkai and Kayal in Tinnevelly district, he found in the old rubbish heaps which mark their long deserted sites, many specimens of chank *workshop waste* (not broken bangles but actual workshop waste), showing that the chank cutting industry is indigenous to Tinnevelly and was largely practised there in long past centuries. Hence the proposed introduction of the industry will be a revival and not the intrusion of an exotic novelty. Enquiries are being made in England for small experimental plant suitable for chank cutting.

27. It was mentioned last year that the "Pearl" whale boat was rather small for her work; with Government sanction we have now taken the "Dan" engine from the 25-ton "Turbinella" for which it was hardly powerful enough, and transferred it to the fully decked 14-ton "Sutherland" which is now a useful boat with a 15-horse power engine and tows the whole fleet of eight laden canoes at fair speed; she thus enabled fishing on days when the canoes could not otherwise have reached the fishing grounds, and thus accounted for catches of about 35,000 shells, value to Government about Rs. 2,240, which would otherwise have remained unfished. The "Pearl" is now attached to the Experimental Stations in Malabar.

28. *Miscellaneous.*—At the instance of Government, the Fisheries department submitted to Government a scheme and plan, drawn up by Mr. Hornell as an Aquarium expert, for the erection at Madras of a suitable *Marine Aquarium* (to replace the present very small but very

popular one), and Marine Biological Institution ; a special committee was appointed to consider the question and reported to Government strongly in favour of the scheme including not only an aquarium worthy of the country and of its position as the only one between Naples and the Philippines, but a place of biological research and instruction, a source of supply of biological specimens for use in educational institutions and for study by savants all over the world, and a suitable home for the Fisheries department which would, in turn, greatly strengthen its position and enhance its usefulness. Mr. Hornell also suggested the foundation of a research fellowship in fishery investigations tenable by graduates of the Madras University in connection with the *economic* work of the proposed institution, a suggestion which was warmly supported by the Committee.

Biological research and supplies.—Mr. Hornell has attempted work in this direction so far as the pressure of other duties and want of provision for such work permitted ; he has been able, though, not departmentally, to supply specimens to research workers at Oxford, the British Museum, and Calcutta, but could do little for the reasons given.

Exchange of publications has been carried out with about 120 other institutions all over the world, and a considerable body of books and papers is being received.

Deep sea fishing was not carried out ; the "Sutherland" was transferred to the Pearl and Chank Fisheries department, and the "Turbinella" whose engine was placed in the "Sutherland," was also on pearl inspection duty in the absence of a regular inspection vessel. Moreover it has been found, in practice, impossible to obtain a crew which, on their own initiative and without expert supervision, will work and modify their work as occasion requires, in unknown and hitherto untried conditions, in purely experimental methods, and with nets, etc., necessarily somewhat different to their own ; this is markedly the case in Ireland and even in Japan, and is a practical stumbling block in Madras. Hence it was proposed, and Government sanctioned the proposal, to obtain a practical instructor from the East of Scotland who would experiment, mainly in drift net and line fishing, in the exploitation of our coastal fisheries in areas hitherto untouched yet probably well within the 100 fathom limit.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., Honorary Director of Fisheries.
Dated—17th July 1913.

1. I have the honour to submit my annual report for 1912–13.

2. The principal operations in hand were—

(1) the West Coast experimental station for experimental curing, canning, and the production of fish oil and guano ;

(2) the oyster farm at Pulicat ;

(3) the Suṅkesula fresh-water farm ;

(4) the stocking of certain tanks ;

(5) the preparation of important piscicultural projects including the Tuticorin marine fish-farm, the Nellore carp and murrel farm, the Colair lake hilsa hatchery and murrel farm, the acclimatisation of tench on the plains, etc. ;

(6) the usual pearl and chank fishery ;

(7) experiments by Mr. Wilson on a large scale at Sunkesula in the destruction of mosquito larvæ by certain fishes ; followed by a practical paper and demonstrations ;

(8) the conservation of the upper waters of the Bhavāni and Moyār on the lower slopes of the Nilgiris ;

(9) the conservation and development of the trout in the upper Nilgiris ;

(10) miscellaneous, which includes minor enquiries, operations, correspondence, etc., too numerous to detail, including, however, the investigations made in Europe by myself and Personal Assistant.

3. *Experimental Station in Malabar.*—This is located at Tānūr and Calicut ; the former is an area of 8 acres of recent sandy accretion from the sea, and all ordinary curing, oil and guano work is carried on there ; the latter is the newly established cannery which however is only temporarily placed in a rented work-shed belonging to the ice factory. Tānūr has been wire-fenced and planted with 500 cocoanuts, all flourishing ; these should in a few years pay the working expenses of the yard, apart from profits due to operations. The yard contains two large store sheds, a good iron shed for oil and guano operations, two curing sheds, besides dryers, smoking boxes, a fly-proof shed for hanging lightly cured fish, various other curing plant, and manure pits for offal,

4. *Oil and guano.*—The oil and guano plant includes two steam boilers with two steam boiling pans of masonry and several of wood—all heated by open steam--besides two copper pans for open fire, presses of various sorts including a centrifugal, two filter presses, and a variety of other plant, the object being to produce first-class yellow oil which, according to invoices and tenders, fetches at least 25 per cent better prices than the common brown oil; a small contract has been made to supply 1,000 gallons of such oil to the Government leather factory at Cawnpore. The steam vats are invaluable for this purpose since the action is rapid and the oil cannot be scorched; a ton of fish and water can be thoroughly boiled, with a minimum of stirring, in 45 minutes from cold with steam averaging 40 lb. Continued experiment since 1908 has led to the precise method and results laid down in the most recent textbook ("Chemistry of the Oil Industries," Southcombe, 1913), viz., the "rapid boiling of the fish with live steam in false-bottom tanks," using fish absolutely fresh from the sea, "separating the bulk of the oil as quickly as possible" by skimming from the surface of the hot mass in the boiling vats, which gives "an oil fairly pale in colour and which needs but little refining," and pressing the residue "when a dark oil is obtained." The whole process is now entirely differentiated from the old indigenous and highly insanitary process of obtaining oil by the putrefaction of masses of fish in old canoes, etc., when the oil, freed from the tissues by putrefactive rupture of the cells, was "charged with putrefactive impurities which are impossible to remove on a commercial basis" (Southcombe). The oil made under the new process cannot be putrid, nor is it even putrescible if re-boiled and filtered at once; the fault found on inspecting village factories is not that the oil is putrid but that it is often scorched and therefore unnecessarily dark, and strong with the smell of burnt oil.

5. Owing to extraordinary local conditions very little oil was made at Tānūr; sardines were enormously abundant but on this part of the coast were young, small, and almost destitute of fat; oil sardines suitable for oil making run about 30,000 to 40,000 to the ton, whereas the generality of sardines in 1912–13 ran at 90,000 to the ton. These gave good guano, but no oil worth mentioning.

Five tons of the guano were sold to the Agricultural College, Coimbatore, on a very good analysis which gave a valuation of Rs. 90 per ton ; the rest was sold to a local firm.

6. Not less than 45 village oil and guano factories were at work on the coast using the new method of boiling the fish ; the number indicates part of the advance made since the first factory was started and profits demonstrated by "Fisheries" in 1908 at Cannanore. In a discussion on the ability of Indians to assimilate new industries of demonstrated method and profit, a British merchant instanced the rapid growth of this fish-oil and guano industry as an argument in favour of such ability, remarking that in three years it had become a matter to be reckoned with. The rush for the industry—for which there were many additional applicants during the year—has led to insufficient care in sanitary matters, and on a reference by the Collector of South Canara I examined a number of small factories of which nine are in one seaside village. Suggestions have been made for the proper conduct of operations, especially in the matter of leading the effluent waste water direct to the sea below high-water mark ; this is essential as the water is charged with putrescible and fermentible matter, and becomes very unpleasant if allowed to run into the sand. All factories will now be carefully inspected on several occasions during each coming season, and simple but obvious sanitary needs will be insisted on.

7. The following table shows the West Coast export by sea of fish-guano for the past three years ; that sent by rail or road cannot be ascertained as the accounts do not separate this class of manure from other classes ; hence the destination of a good deal of guano is not recorded :—

—	1910–11.		1911–12.		1912–13.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	TONS.	RS.	TONS.	RS.	TONS.	RS.
Fish-guano ..	188	13,648	267	17,866	1,872	1,54,916

The whole of the export was to Ceylon, but it is believed that part was re-shipped to Japan and elsewhere. The

exports of fish-oil are not included, since there is a large export of country-made fish-oil which is not yet distinguished in the accounts. By the courtesy of the Customs Department export accounts will in future distinguish "fish-oil, boiled," and "fish-guano" as items separate from "fish-oil" (which includes a lot of oil prepared by the old methods in various parts of the coast including Travancore and Cochin) and "fish-manure," by which is understood the sardine manure dried on the beach.

The absence of oil in the masses of sardines, especially on the South Malabar Coast, led to very heavy operations in drying sardines in the usual fashion on the beach. The wastefulness of this method in valuable constituents owing to the putrefactive loss of nitrogen, etc., has often been mentioned, but may be gauged by the following printed prices quoted by a large firm dealing with estates, viz.:—

	Rs. per ton *bagged f.o.r.*
(1) Fish-guano, guaranteed, 8—9 per cent N, and 7—8 per cent phosphoric acid.	100
(2) Milled fish, 5—6 per cent N, and 4—5 per cent phosphoric acid.	55
(3) Fish-manure (*no guarantee*)	40

No. (3) is the ordinary manure obtained by drying fish on the sand and necessarily contains much adhering sand which partly accounts for its low price. Since five tons of fresh fish boil and dry into 1 ton of guano or dry to about $1\frac{1}{4}$ tons of beach-dried fish, the gain both in money and in nitrogen is obvious, while the whole of the oil, much or little, is an additional asset.

8. The absence of the oil in the fish and the poor prices given for beach-dried fish led me on returning to Tānūr to consider methods of drying *lean* fish without boiling them. Two methods were adopted, viz. (*a*) that of light and brief salting followed by sun-drying, and (*b*) that of artificial drying. In both cases the object is to avoid the loss caused by several days' drying, *without salt* on the beach, where putrefaction, loss by soakage, birds, insects, etc., cause great loss of nitrogen and of actual material, besides being a nuisance to the public; further and great loss is often caused by rain on the drying material. When the fish are even lightly salted and then dried not only is putrefaction entirely prevented but the tissues are hardened so that there is less breakage

of the fish and loss of debris ; nor are the fish attacked by insects. Hence salted fish yield larger quantities of better manure than unsalted fish, and they are not injured by rain since they can be stored without putrefaction till the rain ceases. It is found that one hour in salt is a sufficient protection ; the salt actually used up (by absorption and wastage) is about one-twentieth of the weight of the fresh fish or one and one-third maunds per ton and consequently costs at fish curing yard prices (As. 10 per maund) about Rs. 4–8–0 per five tons of fresh fish or Rs. 3 per ton of dry fish, since five tons of fresh fish thus treated become about 1½ tons dry fish. This fish has been analysed and showed 6·78 per cent of nitrogen, so that it is worth retail at least Rs. 65 as against Rs. 40 per ton of *ordinary* beach-dried fish. Hence there is not only large pecuniary gain but an economic gain to society in the saving of the nitrogen, etc., which would otherwise have been lost by putrefaction and other causes.

The cost of artificial drying is much the same, and it found that the fish when dried by strong heat, say 300° F., break up and become like guano ; this part of the experiment will be continued this year in a proper drier now being built for this purpose and for drying the press cakes rapidly and without loss.

9. *Curing.*—The method of lightly salting sardines just as they come from the beach, without gutting, has been practised for several years in the station ; the fish were usually left *moist* though not in pickle, as fat sardines do not dry well. But the lean sardines of this year, lightly salted and dried for manurial purpose (paragraph 12 supra), were perfectly good for edible purposes as had been shown in previous years, e.g., paragraph 9 of the report for 1911–12. Hence we now place our lean, ungutted sardines in salt for one hour, using up less than one-sixteenth of their weight of salt, and then dry them on barbecues, etc., into sound edible fish—*experto credite*—with absolutely no trace of taint, while the fish, shown by analysis to contain about 9 per cent of salt, remain good indefinitely. I have bought these fish fresh on the beach at less than Rs. 4 per ton at which price the 10 tons of dried fish resulting from five tons of fresh fish cost less than Rs. 30 for fish, salt, and labour ; at Rs. 10 per ton the cost would be Rs 60 ; ordinarily, therefore, one ton of this excellent food may cost from Rs. 20 to Rs. 40 according to the first cost of the fish.

10. After studying the cure of pilchards in Cornwall (September 1912), instructions were sent out on which Mr. Hornell conducted at Tānūr a most useful experiment in true pilchardizing as practised in Cornwall, viz., in placing the ungutted fat fish (pilchards) in heavy salt for a week or two, removing them to barrels with loose staved bottoms, and subjecting them to pressure ; the result after two or three days' moderate but increasing pressure, is a firm, solid mass of moist pickled fish, and a considerable quantity of good and pure oil almost entirely free from stearine since the fish are pressed at normal temperature when the stearine remains solid and cannot be pressed out of the tissues. This was repeated at Tānūr with fat sardines weighing about 36,000 to the ton or 16 to the pound, and resulted in about 6 per cent of perfectly clear good oil, with but slight fishy smell, and free from stearine ; the fish, however, were then dried, and when inspected several months later were firm and good, and free from broken bellies owing to the stiffening given by the salt. As fat fish entirely deserted Tānūr the experiment could not be repeated, but will be closely examined this year, since it results in good human food, moist or dry, and yet extracts, without the use of fuel, the best part of the stearine-free oil ; the fat remaining in the fish improves it as food.

11. *Canning.*—The main efforts of the year were in developing the canning industry of Calicut. Experiments were begun in January 1912 (see paragraphs 14 to 16 of the report for 1911–12) and continued till my leaving for England in April ; Mr. Hornell then ably carried on the work till my return in January. The plant in use was small experimental plant for making soldered rectangular cans sized as for sardines and for herrings, and round $4\frac{1}{4}''$ cans of any depth. The sets of experiments, often with several variants to the set, reached 374 in number, and mainly concerned sardines in oil, plain sardines without oil, mackerel plain and marinated, and plain prawns, besides various minor lines : fish pastes were also worked at. Mr. Hornell and myself are well content with our technical success and we have tentatively decided on certain standards for each class of product ; those of the public to whom samples have been sent are at least equally satisfied.

One result is that Government have permitted me to obtain a superior *can-making* plant of a character determined by my enquiries at home in 1912, which with the larger canning plant already in our hands, will enable us during the current year to turn out products which may be placed on the market for the verdict of the public, for ascertaining both the correct price and value of the several articles, and for the information of those who may care to take up the business either as an industrial or as a trade matter. The factory will also serve as a place of complete instruction in canning lines, where those interested may learn all canning methods and precautions, the class and cost of plant necessary, and the various recipes which we have now more or less standardized ; this will open to capitalists who seriously take the business in hand, all the so-called "secrets of canning," and will provide a healthy, instructed competition for the public favour, and consequently the best classes of goods ; monopoly in such matters is most undesirable since its very secretiveness permits it to place goods of unknown and sometimes undesirable character on the market and at its own prices ; a public canning institution with public instructors and inspectors will substitute publicity for secrecy and mystery. During my enquiries in Europe certain facts came to my knowledge which convinced me of the need for perfect publicity, e.g., products with—it was said—90 per cent of sophistication by means of additions not necessarily unwholesome or bad but *not* the genuine article ; this sophistication is not possible where every detail of an industry may be learnt by all who wish to compete for public favour, so that manufacturers will necessarily be circumspect in the methods and materials of their products. Moreover, the existing and, still more, the improved Government station, with its plant, experience, and skilled instruction, will prevent all those losses of capital and those risks to the public which would arise from the intrusion of rash and hasty ignorance into this seductive enterprise.

12. It is certain that canning, properly conducted, is a method eminently suited to the tropics, especially for fish which so readily taints. The enormous development of this industry in the United States is little studied

in England where canning for home use is not greatly needed or practised ; but for India it has great lessons. The only alternatives are refrigeration or curing ; the former is expensive and temporary in result, the latter is difficult to carry out in such a way that the products are thoroughly digestible and generally acceptable ; light curing is difficult and risky both for the producer or retailer, while hard curing produces goods which have lost much of their savour, digestibility, and nutritive value ; smoking is not yet acceptable to the general public. Pickled fish ought to be a universal product and is a line which "Fisheries" is taking up as a rival to canned goods ; the want and cost of barrels or other containers and the cost of freight are against the popularity of pickled goods which, moreover, will not keep indefinitely. Canned goods, however, can be produced at fairly cheap rates (not so cheap of course as ordinary cured goods) which, having been thoroughly sterilised, will be absolutely free from the risks attending badly cured or so-called "fresh" fish, which will contain the maximum of solid food in a minimum of space and will therefore transport well and cheaply, will always be ready for consumption even without cooking, and will keep indefinitely ; it is not generally known that properly canned goods improve by keeping and that respectable French canners will not issue canned sardines till six or twelve months after manufacture. Canning, as specially studied in the Govenment station for the production of *plain and cheap goods*, is a most useful advance in the curing industry, and partly from lessons recently learnt in England, certain lines of economical canning have been adopted and standardized which will provide cans of $\frac{1}{2}$, 1, or more pounds of solid, sound, and wholesome food thoroughly sterilized and excellently prepared, and with much less contents of water than fresh fish, at not more than the cost of (so-called) fresh fish as packed in ice and sold upcountry.

13. A bitter controversy was submitted to the Magisterial Courts in England in 1912 as to whether any fish except those canned by the French (or Portuguese) canners can be labelled and sold as sardines, it being contended by the French canners that only the young "Clupea pilchardus" found on their coast, can lawfully be called a "sardine," and that sprats, brisling,

etc., elsewhere canned in oil, cannot be so described for trade purposes. The matter has again been revived, owing to the persistence of the non-French canners, and is still subjudice. This is of much interest to Madras, since our "sardines" are perhaps not "Clupea pilchardus" but "Clupea longiceps" and "Clupea fimbriata," and the same objection might conceivably be raised to Madras trade labels. But our fish especially "Clupea longiceps," are sardines in appearance and flavour; we have the highest ichthyological authority (e.g., Dr. Day) for calling them "sardines," and they have in fact been so called for at least a century, since a Ceylon Ordinance of 1824 speaks of these fish, as fish well known by that name; hence we have both legal and scientific authority for calling our fish "sardines" which name I have hitherto placed on my labels; the words "packed in India" may, however, be properly added.

14. *Fresh fish.*—Nothing can ever make "fresh fish" both cheap and good up-country so long as ordinary refrigeration is the only method available; it can only be cheap (or moderately so) if ice is spared, and then it is not good; fresh fish as received even on the Nilgiris, is not cheap, and it is often not good. The necessary first cost of ice in the tropics (necessary because of the temperature of both water and air, because of the small size of the plant in use, because of the cost of skilled attendance), etc., the large necessary wastage, the large quantity required on long journeys especially in the absence of refrigerating cars or compartments, the distance and consequent cost of transport of bulky ice parcels, are all against cheapness, while fish in general cannot be completely trusted, however thoroughly iced, which are caught, brought to shore, and delivered at the icing places, by the methods and with the delays now in vogue. Moreover, since fresh fish contains 75 per cent of water it must always be an expensive food, especially to send up-country, when ice and transport have to be provided for this 75 per cent of water, while the nature and method of the packing and transport still leave much to be desired; direct contact with scanty ice while on long journeys at tropical temperatures, tends also to sodden the fish.

As reported in previous years I have sought to substitute light-cured fish for fresh fish, and have very

fairly succeeded ; this class of fish, now including prawns, will keep good for some days and eat very well. But when in England in 1912 other methods of keeping fish fresh were studied, two of which were specially noticed that year by the trade. One, viz., the method of conservation by CO^2 (carbonic acid gas) is not practicable in this country, demanding plant and materials which are very expensive, while the cost of vessels strong enough to contain gas at a pressure of several atmospheres and, above all, the cost of transport of fish by road and rail in such vessels, puts the process—even if successful—out of court. The other method (Henderson's) was taught me by the inventor and has great possibilities; he has generously permitted us to use his process freely in India "for the good of the people" and has communicated further improvements ; refrigeration is the method adopted but the details differ largely from those of ordinary freezing and packing in ice, should make both the freezing and the transport cheaper, and should give far more satisfactory results. The method was tried in an imperfect way—imperfect for want of the correct plant – but the results were eminently satisfactory ; the cost, as carried out, was unduly high since ice at six pies per pound had to be substituted for mechanical refrigeration, but the result showed that fish could be despatched *without ice* and yet keep perfectly good, even on the plains, for three days ; fish sent (without ice) to Tuticorin, etc., was excellent on the third day. With plant recently sanctioned by Government this line of experiment will be pursued during the current year.

15. *Pisciculture – Marine.*—The detailed plan and estimates for the 160 acre 7 lagoon fish-farm at Tuticorin mentioned in paragraph 28 of last year's report were not received from the Public Works Department in time for execution during the year under report.

The oyster farm at Pulicat was continued by Mr. Hornell as Marine Assistant, and proved many things ; conclusively that excellent oysters can be cultivated in sanitary conditions with much ease and profit and marketed in the best condition within 20 months from spat-fall ; in July 1912 the oysters spawned in November 1910 were fully mature and in splendid condition for market. But it is also true that, as in other tropical enterprises, especially those of the cultivation of the soil,

the unexpected occurs ; the Pulicat bar closed during the year—this happens about once in five years it is said—and consequently the oysters were, soon after reaching maturity, troubled by alternate droughts, leading to undue salinity and high water-temperature, and by floods of fresh water causing sudden falls in salinity and inundations of mud. Hence the oysters suffered heavily in numbers and condition from unforeseen external causes. But with the re-opening of the bar normal conditions returned, an abundant spat-fall took place so that the collectors, cultch, etc., were covered with brood, and there is now a fine crop of young oysters which should mature in July 1914 ; the older oysters recovered also and were put on the market about the close of the year under report. This temporary set-back in no way affects the results of the experiment as a matter of successful cultivation ; conception, method, and results were excellent, but the locality was subjected to unforeseen adversities *ab extra*. The experiments will hereafter be conducted both at Pulicat, Tuticorin, and probably elsewhere, in the light of the experience now gained. Pulicat was originally selected as fairly handy to Madras, but Mr. Hornell has repeatedly pointed out that it is not an ideal situation compared with other localities both on the east and west coast.

Mr. Hornell wrote during the year an informing pamphlet on oysters as food ; this has recently been issued to the public.

16. *Pisciculture—Fresh-water.*—This was continued by Mr. H. C. Wilson as Piscicultural Expert who completed his first term of service with Government during the year, and has been re-appointed to the post which has now been made permanent.

As in previous years the Sunkesula fish farm was the *piece de resistance ;* a long step was taken towards the object of its institution, by the stocking of 41 miles of the Kurnool canal with carp, and Mr. Wilson reports that the fish rentals have nearly doubled. The murrel farm was brought to a stage when sale became not only advisable but necessary, and Government sanctioned the building of a special market stall in Kurnool where live fish will be sold ; being air-breathers murrel travel well for at least 24 hours and can therefore be despatched to out-stations. The character and work of the farm

has been described in some detail in an inspection note printed in G.O. No. 782, Revenue, dated 15th March 1913, which led to a demand from the Government of India for copies of the farm plan.

Minor operations consisted in the stocking and conserving of several large tanks, while conservancy operations proper were also conducted as usual in the upper waters of the Bhavāni, Moyār, and Cauvery. The hilsa-hatching operations on the Coleroon were a failure in 1912, owing to the difficulty in obtaining ripe females. Mr. Wilson observes that this difficulty occasionally happens in America with shad, and technical papers lately received from the United States of America show that this has just occurred there on a large scale.

Mr. Wilson's more difficult work lay in working out certain important projects, viz., that at Allur in Nellore, to take the place of the Kanigiri project to which the Public Works Department refused assent for technical reasons relating to the Kanigiri reservoir, and a new one at the Colair lake in which floating hatchery is to provide swarms of hilsa fry which should not only greatly increase the yields of hilsa in the Gōdāvari and Kistna rivers, but furnish stock for transport to the west coast rivers; in addition to the hilsa hatchery a large murrel farm will be located in a position whence the fish can be transported in quantities by rail to various markets. Both these projects are still in the stage of investigation. Mr. Wilson is also engaged on a scheme for acclimatising tench from the Nilgiris for use in our waters on the plains.

Incidentally in boring for fresh-water at Nellore it was discovered that semi-artesian water was available, the water rising in a 70-foot bore to within 3 feet of the surface after the tools had passed through a thick bed of clay; this fact may be of use agriculturally.

The Nilgiri trout prospered during the year and Mr. Wilson reports that Rs. 1,495 were obtained from licenses. Poaching by men and otters unfortunately developed, and the supplies of fish food proved insufficient for the large head of rapidly growing fish, some weighing 6 lb. and over, so that Mr. Wilson has had to introduce shrimps and other live food from lower waters.

A most useful investigation was made at Sunkesula in the growth and observation of various classes of fish

for the destruction of mosquito larvæ ; aquarium experiments were continued in a pond of considerable size and from the data obtained Mr. Wilson read a very practical paper at the "All India Malaria Conference" in Madras city which are now found to be free from larvæ ; he also supplied a number of Municipalities with the necessary fish carriers for stocking purposes. His paper shows that the Chelaeargentea is a most efficient larvicide, and that his ponds, of considerable size, are kept entirely free from mosquito larvæ, chiefly by their activity ; besides these the various species of *Haplochilus* are very useful and can be transported to long distances ; for brackish and salt waters and swamps he recommends the *Therapon jarbua*.

Madras fresh-water pisciculture is a most difficult subject owing mainly to the non-permanence of its waters and their use in irrigation ; hence the framing and execution of practical projects is a matter of great difficulty which Mr. Wilson is gradually overcoming.

17 *Pearl and chank fishery*.—The supervision of operations in this branch is Mr. Hornell's work ; these are separately and fully reported on as usual. The year was one of comparatively poor yield owing mainly to unpropitious weather and the increasing difficulties of obtaining divers. The net profit was Rs. 10,124 to which the motor-boat Sutherland contributed largely by towing canoes out in weather when they could not otherwise have reached the banks or returned from them. Mr. Hornell's report deals in detail with the work, past and prospective, in chanks and pearls, and it is hoped that a new era will begin this year with the advent of the new motor inspection vessel and with other expected advantages, in which the Tuticorin fish farm should take a prominent part since the cultivation not merely of the pearl oyster but of pearls will be a feature of the operations under the skilled experiments of Mr. Hornell. The South Arcot chank contractor duly paid his rental and has now tendered for the Tanjore collection.

During the year Mr. Hornell wrote the second and a valuable part of his monograph on chanks, taking up the matter from a social, industrial, and artistic point of view ; this has been printed and is now before Government ; also several articles on fish parasites, the cyclic character of the pearl fisheries, etc.

Experiments were made in England by an engineering firm, skilled in similar matters, in the cutting of the chank shell by machine tools, but with poor results ; being porcellaneous in character and of peculiar corpuscular structure which results in brittleness in the sections if roughly sawn, it cannot be dealt with by ordinary shell-cutting machine tools, such as are used in making buttons, etc., from nacreous shells, but apparently requires either the slow rhythmic motions of a heavy but finely toothed tool worked by the delicate human hand, or a wheel similar to a lapidary's slitting wheel, charged with a first-class cutting material such as diamond dust or possibly carborundum.*

18. A very important matter, viz., that of net-making by hand-worked looms was specially investigated by Mr. Govindan who of his own initiative examined the matter in Scotland, Ireland, and Cornwall ; on obtaining sanction for the purchase of a machine an order was placed in Bridport, and Mr. Govindan spent a month (partly while on privilege leave) in mastering the setting up and working of the machine. This is intended for instructional purposes on the west coast where nets, as Mr. Govindan had found, cannot be made fast enough to supply the demand ; a single machine will do as much work as a village of fishermen, and better work. The Cornish method of curing pilchards together with that of expressing the oil and packing the fish in barrels, and of making the barrels, was closely studied on the spot, and the question of the provision of fresh fish by refrigeration was not only closely examined (as in Henderson's experimental factory ; see supra, paragraph 18) but the manufacturers of refrigerating machinery were interviewed. Mr. Govindan is submitting a special report on his tour of duty and his personal share in numerous investigations.

The project for a marine aquarium and marine biological station advanced to the production of architect's plans in the preparation of which Mr. Hornell's expert assistance was sought and given. Apart altogether from the need for purely scientific research,

* Later enquiries were made in July 1914 at the Imperial Institute, London. The Director, Dr. Wyndham Dunstan, F.R.S., was good enough to take up the matter, and from samples of machine cut sections which he has obtained, it seems that success is now probable with machines of no great cost.

there are many practical problems presenting themselves for enquiry ; such for instance as the life history of food fishes, of the organisms they feed upon, and of their enemies, the examination of various marine products, and so forth. For such purposes, as well as for research by savants and students, and for the provision of specimens of marine life for scientific and educational purposes, the new institution with its laboratories, library, and museum, will be most valuable, while providing in the aquarium proper a means of popular and most interesting instruction.

19. *Progress.*—The work of "Fisheries," having hitherto been mainly that of enquiry and experiment, has only been slightly devoted to demonstration ; hence there has not yet been much positive advance in fishery matters among the fisherfolk and curers themselves. But the work of the Government experimental stations, the attempts in several places to start out on the new lines, the awakening of public interest in fisheries, the training of several men, including our own staff, in the stations, and the visits of enquirers, have already produced a new public interest in fishery development—a very good beginning among conservative folk in an industry hitherto wholly untouched by progress or even by industrial thought.

Letter—from Sir FREDERICK NICHOLSON, K.C.I.E., Honorary Director of Fisheries.

Dated—Madras, the 10th June/13th July 1914.

I have the honour to submit my annual Fisheries Report for 1913–14.

2. The staff remained as in 1912–13 except that Mr. V. Govindan, B.A., Personal Assistant to the Honorary Director, was, by G.O. No. 1095, dated 13th April 1914, made a gazetted officer with the appellation of Assistant Director and a salary of Rs. 400 per mensem, the post of Personal Assistant being abolished, while Mr. A. K. Menon, recently a Government of India student in England in the oil and soap industries, was appointed temporarily as Oil Chemist and posted to this department on a pay of Rs. 250 per mensem (G.O. No. 3553, dated 3rd December 1913).

3. The principal operations in hand were—

(1) The West Coast station for experimental curing, canning and the production of fish oil and guano;

(2) the oyster farm at Pulicat;

(3) the Sunkesula fish farm;

(4) the stocking of certain tanks;

(5) the preparation of important piscicultural projects including the Tuticorin marine fish farm, the Nellore carp and murrel farm, the Colair Lake hilsa hatchery and murrel farm, the acclimatisation of tench on the plains, etc.;

(6) the usual pearl and chank fishery;

(7) work by Mr. Wilson in anti-malarial operations such as the breeding and distribution of larvicidal fish;

(8) the conservation of the upper waters of the Bhavāni and Moyār on the lower slopes of the Nilgiris;

(9) the conservation and development of the trout in the upper Nilgiris;

(10) work by the Oil Chemist; and

(11) miscellaneous.

4. *Experimental station, Malabar.*—This, as in 1912–13, was located at Tānūr and Calicut; remarks are the same as in paragraph 6 in the report of that year.

5. *Fish-oil and guano.*—The work mentioned in paragraph 7 of last year's report was continued at Tānūr and improved; the percentage of first-class yellow oil now obtained is larger than in 1912–13, and averages

above 50 per cent of the outturn; this oil was recently described by a European buying firm as "unique," by reason of its purity, colour and slight odour; the Oil Chemist attached to the department has also given it a high technical value.

The conditions of manufacture were again unfortunate, as the shoals of fat fish were not only few but ceased at a very early date; this was the case all along the coast and merchants who had made forward contracts were seriously embarrassed. Most of the best oil was retained for experimental purposes, but a good profit was nevertheless realised on this manufacture.

The profits ordinarily obtainable may be gauged by the fact that as against the single factory of 1908–09 there were at the close of the year no less than 211 private factories in Malabar and South Canara, the former district having two-thirds of the number. Moreover, the quantity of fish guano (that is, the dried product obtained from the boiled fish) exported by sea alone, increased—notwithstanding the shortness, etc., of the season—to 4,726 tons as against 1,872 in the previous year; to this must be added the exports by road and rail which are not known. The above weight of guano represents at least 25,000 tons of raw fish, so that the new method, due entirely to the work of this department, is now taking an appreciable share in the fish manure trade, while the oil represents a gain hitherto lost. The oil exports by sea were 1,511 tons, of which above half went to Germany.

6. It may here be well to mention a point of importance, viz., the apparent economic sin of turning these fish, so valuable as food, into a soil fertiliser. At first sight it seems wrong (and the sentiment has been reflected in previous reports) that good nourishing human food should be turned into manure. But there are considerations which, especially in the tropics, put a different complexion on the matter: (1) that with the present means at disposal, or, at all events, under indigenous methods of curing, the masses of sardine which are sometimes caught in vast quantities within a few hours, cannot be turned into safe and wholesome food (especially when the fish is very oily) owing to the rapidity of tainting and the paucity of labour, so that the turning of the fish into fertiliser either as guano or as

dried fish manure is a necessity; (2) that when the fish is not oily it is of inferior value as food; (3) that when fish is deprived of its oil (itself a very valuable commodity) or is non-oily, the residue or mass, if skilfully applied as a soil fertiliser, produces *more* human nutriment in the shape of cereals, etc., than if it were consumed directly, as fish. Hence the method of reducing the fat fish to oil and guano, or the lean fish to ordinary manure, does not necessarily deprive the country of food, but increases the total supply and yields an economic and industrial gain.

7. In this connection it may be conveniently mentioned here that enquiries in Great Britain and a perusal of agricultural reports showed that fish meal or scrap is very largely used in western countries as food for cattle, poultry, etc. Correspondence ensued in 1913 with the College of Agriculture at Coimbatore and a half-ton parcel of lightly salted and dried lean sardine was sent to the college in April 1913. The experiments conducted there are said to have been very successful, and though no details have been communicated to this department it is understood that a report is being drawn up on the matter. The success or otherwise of the food turns largely on the question of price which is very variable.

8. *Curing.*—The year was a bad one for fishermen in general, and our station being without the aid of any deep-sea boats such as those from Ratnagiri, no great advance was made except in two directions, viz., the treatment of fat sardines like Cornish pilchards and the curing of prawns.

9. *Pilchardising fat sardines.*—In the previous year instructions were sent out from Cornwall to treat fat sardines as pilchards, viz., to cure and harden the *ungutted* fish by several weeks in heavy salt (1 lb. salt to 3 of fish) and then to submit them to pressure in barrels when much of the oil is extracted, and the fish remain as a hard mass in the barrels; these are largely exported to Italy. It was found that the method was successful, and a very good oil was obtained, but for various reasons the cured fish did not keep properly. The experiment was repeated in the year under report, but the pressure was still insufficient; the fish, however, kept well for months. Regular pilchard screws for applying pressure

were obtained during the year from Plymouth, and a proper pressing battery will be set up and tried in the current year.

It will be observed that this is one method of satisfying the demand for fish as human food while obtaining the valuable oil as a separate product ; since the fish are not gutted they can be very rapidly placed beyond fear of taint, for they are simply roused up at once with the salt just as they are received from the sea, while the large quantity of salt used keeps the fish good almost indefinitely if the air is kept away from them ; this is secured by retaining them airtight in the barrels in which they were pressed, while the heavy pressure used consolidates the fish into an indurated yet slightly moist mass. These fish boiled up with rice and vegetables, as the pressed pilchards are cooked in Italy, should prove very good food.

10. The curing of prawns is a useful advance. Hitherto the only method known to the general curer was that of simply strewing the prawns, wholly unsalted, on the beach to dry, the resulting product is *always* badly tainted or of very strong odour. Moreover, as prawns are mostly caught in large quantities in the monsoon period (e.g., prawns worth Rs. 15,000 at low prices were caught in a single day at Tānūr in July) it is often difficult to dry them at all ; consequently, while the fishermen get low prices for their catches, the curers run the risk of losing both their money and their prawns. Obviously then it is necessary to cure or preserve the prawns by salting, etc., and to find some mode of drying them.

The first step now taken at Tānūr is to boil the prawns in salt water and thus to sterilise and partly cure them, the second is to shell the boiled prawns, the third to salt or brine them for a few minutes only, since the shelled flesh rapidly take up salt, the fourth to *semi-dry* them. It is found that this method yields a product which is suitable for the best tables, and keeps perfectly for months, while, being only semi—instead of bone—dry, it retains the prawn flavour and with but slight soaking is an excellent and nutritive article of diet. Fully-dried prawns are comparatively savourless, and are both difficult to cook and to digest ; the semi-dried prawns have none of these disadvantages.

11. But the shelling process is too slow when dealing with large masses, and it was subsequently found that the fish can be equally well salted whole—after boiling—and can then, if necessary, be shelled more at leisure, or semi-dried in the shell.

These products have been tried scores of times with invariable success and great appreciation by consumers; instructions have now been drawn up for trying experiments on a considerable scale and with improved methods during the current season.

12. *Drying.*—For artificial drying, as mentioned in previous reports, two driers have been put up; the large one, intended for drying manures, has not yet been used as it requires personal supervision and instruction during the first experiments. The small one intended for drying fish, prawns, etc., has been frequently operated with success, but it is difficult to teach ignorant men the true method of operating a drier even when worked with a simple slow combustion stove. Full instructions have been issued for further work during the monsoon. No drier can be both cheap and automatic, and automatic working, i.e., working which will go on at equal temperatures and without attention, is essential in a country where inattention, especially at night, is certain, so that fires either go out or burn too fiercely and where it is difficult to get men to understand the principles of drying so that night and day drying, or drying in hot weather or in the monsoon are treated alike.

13. *Canning.*—Much of my personal attention was devoted during the year to continuing and improving the canning experiments begun in January 1912. As the plant available was still only the small experimental plant of 1912, only a few thousand tins were packed, chiefly with sardines (plain, i.e., without oil, in curry, or with oil), mackerel and whole prawns, while prawn and smoked mackerel paste were also made in some quantity. Considerable advances have been made in technical success, especially in the use of the oils obtained from England; it was also found that the first-class sardine oil made in the Government factory is an excellent packing oil, and this opens out a large additional market for such oil and a method of cheapening canned fish; experiments will be continued next season in oil packing.

The canned products find a very appreciative market, and the difficulty is not to sell the goods but to supply the demand, especially as experience has now taught us that the lean fish of the later season are useless for canning plain or in oil, and require some addition such as curry-powder or tomato or mustard sauce.

14. The new solderless plant from England arrived during the year, but owing to difficulties about a site the factory for its accommodation is only now being built, and will be ready for next season's work, when, if fish are available, it will be possible to turn out thousands of cans where we now pack only hundreds. The new factory is at Beypore where it will have the advantage of supplies from both sea and estuary, while even the deep sea boats can come up to the factory gates.

15. Fish paste work was also successful, but requires a somewhat larger and better plant which, while costing only a trifle, will enable us to perfect our standard products.

16. The labelling as "sardines" of canned fish other than the immature "Clupea pilchardus," alluded to in paragraph 17 of last year's report, has been magisterially declared illegal in Great Britain, but the matter is under appeal. The use of the words "Indian sardines" for our fish is certainly justifiable.

17. *Fresh fish.*—The useful process mentioned in paragraph 18 of last year's report was again experimented on with much success, but was not carried out in its integrity as the refrigerating plant ordered in the autumn was only received in March, too late for being set up during the season. It is now being placed in position at Beypore, and will be thoroughly tried next season.

18. The possession of this small refrigerating plant will at last render possible the method of fish drying *in vacuo* with a vacuum stove of my own which has been awaiting proper trial for several years. It will also enable me to experiment in a preservative method of great promise and cheapness.

The preservative method alluded to at the end of paragraph 18 of the previous report has also awaited the receipt of the refrigerating plant, but as it has been patented in India and apparently demands a chemical (H_2O_2) which in the tropics is of great instability and

cost, success is doubtful. The matter will be enquired into in London, etc., during my present visit to England.

19. *Deep-sea fishing.*—This has not yet been practicable, since the energies of the staff in initiation and supervision are limited by the natural bounds of human capacity, and the personnel is insufficient. Moreover, as decided several years ago, it was thought advisable, especially with a limited staff and scanty experience and imperfect boat equipment, to endeavour to deal and to show the best methods of dealing, with existing catches, which amount to hundreds of thousands of tons, before attempting to increase the bulk of the catches. A full-sized department working upon intelligent, enterprising material might have attempted both classes of operation simultaneously, but a small staff, gradually feeling its way, devising its own methods and gathering its experience from its own experiments, necessarily limited its operations and took the line of least resistance and difficulty. Hence, and for other reasons, the master-fisherman, sanctioned in G.O. No. 822, dated 21st March 1912, has not yet been recruited, but this omission will, it is expected, be supplied during the current year and a scheme for his employment has already been drawn up for submission to Government. The new curing station at Beypore with the shelter for sea-going boats provided in the river estuary will enable us to turn attention to the catching as well as to the curing branches of our work.

20. *Pisciculture—Fresh-water.*—Mr. H. C. Wilson continued to be Piscicultural Expert throughout the year and, while supervising practical operations on the Nilgiris and at Sunkesula fish farm, toured extensively in eight other districts for the preparation of projects and, very specially, on anti-malarial duty.

21. *Sunkesula fish farm.*—In this farm the operations of the previous year were continued and some sixty miles of the Kurnool-Cuddapah Canal were stocked with young fish, while the experiments in the breeding and sale of murrel were carried a stage further. Mr. Wilson reports as follows :—

"9. *General work.*—The general work at the Sunkesula fish farm progressed during the year, the new Superintendent taking more interest in the detail work, keeping the screens in order, etc.

"10. Experiments were carried out with the eggs and fry of *Ophiocephalus punctatus* and *O. striatus re* hatching and rearing under artificial conditions.

"11. It was discovered that several minute water-insects play an important part in the destruction of the ova and fry under natural conditions. The worst offender in this respect was found to be the small water-flea *Daphnia pulex*. These minute insects attack and destroy the fry in their early stages and the ova throughout the hatching period. Frogs destroy both ova and fry, but the parents who guard their eggs and young can deal with this natural enemy, whereas they are helpless in the former case.

"12. Fishermen take advantage of this parental affection for the capture of the big fish. They locate a nest and bait with a frog which they dangle in close proximity to the eggs or fry and the parent fish are easily caught. The eggs or young fry are then left to the mercy of all enemies and consequently very few, if any, survive out of the original number in the nest.

"13. The experiments were to determine the following, viz :—

(1) most suitable hatching appliances ;
(2) periods of hatching at different temperature ;
(3) most suitable water temperature for producing healthy fry ;
(4) best artificial food for rearing fry ; and
(5) rate of growth, etc.

"14. These experiments are not yet complete, but a lot of useful information was obtained.

"15. The most suitable hatching appliances were found to be glass tanks where the eggs and fry can be kept under constant observation and the presence of minute enemies detected at once. The water temperature ranged between 76° and 84° F., an average temperature of 78° seemed to be preferable. Various artificial foods were tried, the most suitable for the very early stages (just after absorption of the yolk sack) seemed to be the soup of crushed crab.

"16. Notes on the periods of hatching rate and growth of fry were taken together with specimen fish carefully preserved at various stages.

"17. Before any work can be published on the artificial hatching and rearing and most suitable appliances for dealing with these particular fish, it will be necessary to carry out further experiments and this will be done in due course"

Many thousands of murrel fry were removed from the Sunkesula farm during the year and turned into Edurur swamp for growing purposes. Large numbers of the quick-growing varieties of carp from the farm were distributed over 60 miles of the Kurnool-Cuddapah Canal. Great difficulty of rapid transport is found and I am afraid to transport fish below the locks to Nandyal, Ayyavankodur and Kanala tanks would take too long with the present methods and they will have to rely for the present on the extra fish from the upper waters. The motor-boat unfortunately was found not powerful enough for this work.

* * * *

During the year under review a new and valuable larvicide *Polyacanthus cupanus* was transported from the West Coast (Cochin) to the Sunkesula fish farm for breeding and distribution purposes.

Some fresh blood was introduced amongst the other lavicides at the farm from Cuddapah *(Haplochilus panchax)*.

*   *   *   *

Live fish market.—The construction of the live fish market sanctioned in G.O. No. 1191, Revenue, dated 23rd April 1913, was completed and fish will be sold therein soon after the opening of the canal, *i.e.*, after the 15th June next.

23. *Allur and Ippur.*—A great deal of investigatory work, especially in boring for fresh water, was done at Allur in the Nellore district where an apparently excellent site had been selected by Mr. Wilson for a farm in substitution for that originally proposed at Kanigiri which the Public Works Department were unable, for irrigational reasons, to sanction. But since an abundant fresh water-supply was a necessity, and the borings yielded only salt water, this site also had to be abandoned. It is interesting to note that the water in the bores was apparently artesian rising nearly to the surface, and was, in at least one case, of double the salinity of sea-water; it is possible that salt might be more readily made from this supply than from sea-water. Mr. Wilson subsequently found a site at Ippur in the same deltaic tract which fulfils his wishes and he spent a good deal of time on the new project which has recently been submitted to Government.

24. *Colair scheme.*—This remains in abeyance since the removal of stake-nets and fixed engines from the lake, river and channels is a preliminary condition *sine quâ non*; it is understood that the matter is under consideration in the Public Works Department.

25. *Acclimatisation of tench.*—Mr. Wilson, after some search, discovered a site near Hosūr which will form the first stage in acclimatising tench from the Nilgiris; thence they will be taken to Sunkesula and other farms.

26. *Hilsa hatching.*—Very little work was done in this matter as ripe spawners were not obtainable when Mr. Wilson visited the Lower Anicut.

27. *Stocking of tanks.*—Two large tanks were stocked, viz., Daroji and Markapur. It may be stated here that the rentals obtained from the canal and tank fisheries slightly exceeded the compensatory grants paid by Government to the District Boards.

28. *The breeding of larvicidal fish.*—Much of Mr. Wilson's time and energy during the year were, by order

of Government, turned to anti-malarial work in visiting malarial tracts and in the breeding and distribution of larvicidal fish. He had experimented at Sunkesula on these larvicides, and had given demonstrations and instructions to local bodies, and had read a practical paper at the Anti-malarial Conference in the previous year ; his success resulted in his deputation to Cuddapah to examine the town and its surroundings and to stock its waters with larvicides.

This work is likely to prove of immense value in the near future and Mr. Wilson is to be congratulated on his foresight in the experiments made by him in previous years at Sunkesula on the breeding of these larvicides.

A similar investigation was, by order of Government, carried out by him in company with Major Ross, I.M.S., on the conditions obtaining at Cochin which appeared to favour elephantiasis ; Mr. Wilson submitted a joint report on this matter.

29. *Nilgiri operations.*—These under Mr. Wilson, continued to be most successful ; the stock of trout is said to be very great both in the number and size of the fish, and fresh supplies of live fish food had to be introduced.

30. Conservancy operations in the upper waters of the Bhavāni and Moyār continued as in previous years.

31. *Pisciculture—Marine.*—Mr. Hornell, F.L.S., as Marine Assistant, writes as follows:—

Edible oyster-culture.—During the past year the oyster farm at Pulicat became fully stocked with many hundreds of thousands of oysters produced from the abundant spatfall of November 1912. The growth of these young oysters has been so rapid and satisfactory that it was decided to begin selling operations in January of this year, when the oysters were fifteen months old. The season was therefore opened with these oysters on 23rd January last and between that date and 31st March 1914, 21,450 oysters were sold. The sales of the oysters for the year ending 31st March 1914 amounted to 37,400 and brought in the sum of Rs. 458-12-6.

Fish farm at Tuticorin.—In spite of all efforts to expedite delivery the material requisite for the barriers between the lagoon and the sea was not received till January of this year, when it was too late to begin operations as the run of fry necessary for the stocking of the farm was over for the season. All material requisite is now in stock and as soon as the rains come the farm will be stocked and the barriers erected. Meanwhile samples of the fish frequenting the lagoon are obtained at regular intervals whereby much information useful to the future conduct of the farm, is being accumulated.

While on privilege leave during the year Mr. Hornell devoted a considerable period to the study of practical mussel-culture in the south of France, in view to work out here in the near future. The controlled culture of pearl oysters and of pearls is noticed below.

32. *Pearl and chank fishery.*—This will, as usual, be separately reported on in detail; only salient features will be mentioned here.

33. *Pearl fishery.*—There is no prospect for years of any pearl fishery on the Tinnevelly banks, owing to the absence of oysters, but an inspection of the Palk Bay waters near Tondi resulted in the discovery of a fairly mature bed of oysters estimated at twenty millions in number, and a fishery will probably be held there in September next. The fact is remarkable because no pearl fishery or pearl oyster bed has ever been known before in Palk Bay which is north of the Pāmban channel, all fisheries having hitherto taken place to the south in the Gulf of Manaar where alone pearl oyster beds have been worked from time immemorial. Moreover, Mr. Hornell reports that the oysters are living on a bottom much softer and more muddy than he has ever known them to thrive on elsewhere. It is also noteworthy that this new discovery in Palk Bay is due partly to the recent renting of the Rāmnād chank fisheries from the Raja of Rāmnād which led Mr. Hornell to turn attention to that area, but mainly to the acquisition in October 1913 of the inspection schooner *Lady Nicholson* which enabled Mr. Hornell to survey the area in question upon hearing reports that pearl oysters had been picked up on the Tondi shore; Mr. Hornell's zeal and perseverance under trying conditions then enabled him to locate the bed in question. As the first fruits of the new schooner's work the discovery is very gratifying.

34. *Pearl culture.*—Mr. Hornell drew up during the year a scheme for cultivating the pearl oyster under controllable conditions in a regular farm, and for inducing the growth of pearls, both attached and free, in these controlled oysters. He found an excellent site on Krusadai island close to Pāmban, and sketch plans and estimate for the farm have recently been submitted to Government. The recent discovery of pearl oyster in Palk Bay will provide abundant material for the farm

where oysters will be grown and treated for the production of pearls. From Japanese facts it is almost certain that the farm will be very lucrative, even if only "attached" pearls are grown, but Mr. Hornell is sanguine of success in inducing the growth of the more valuable "free" pearls and has already forwarded a paper to the Linnæan Society with specimens of his first results in this direction.

35. Mr. Hornell has also ascertained facts in the life history of the pearl oyster which show that its free swimming stage endures far considerably longer than was hitherto believed ; this is important in considering the chances of spatfalls. In this connection may be mentioned Mr. Hornell's arrangements for ascertaining the set of the currents in the Gulf of Manaar, by means of drifting bottles ; he is now carrying this out on an extended scale.

36. *Chank fishery.*—Mr. Hornell writes as follows :—

"3. *The chank fisheries.*—The past year is notable for the final consolidation under direct Government control of the whole of the chank fisheries carried on off the East Coast of this Presidency. This has been attained partly by leasing the Rāmnād fishery from the Raja of Rāmnād and partly by assertion of immemorial sovereign privilege. By proclamation in the *Fort St. George Gazette*, dated 23rd December 1913, Government reminded the public that the right to fish chanks in the sea bordering the various districts of the Presidency is a prerogative vesting from time immemorial in Government. The position being thus defined, it became possible to extend fishing leases the whole length of the Coromandel Coast, from Tanjore in the south to Nellore in the north. Further north it is unnecessary to go as Nellore district marks the effective northern limit of chank distribution in the Eastern Coast of India. The rights to farm the fisheries off (*a*) Tanjore, (*b*) South Arcot and (*c*) Chingleput and Nellore districts, have now been leased out and bring in respectively Rs. 660, Rs. 516–10–8 and Rs. 336–10-8 per annum, the whole of the remainder of the East Coast to the south of Tanjore being fished departmentally.

The control of the Rāmnād (and Sivaganga) chank fisheries should react favourably on work on the Tinnevelly beds, since the two fisheries are at somewhat different seasons, so that it will be possible, by inducing divers from Tuticorin to fish on the Rāmnād coast and *vice versa*, not only to get a greater force of divers to work at each place, but to give comparatively continuous work to them, and thus remove one main cause of the discontent felt by divers whose work has hitherto been confined to short periods, which, moreover, if conditions were unfavourable were sometimes very unremunerative."

The Coromandel fisheries as Mr. Hornell rightly names those of the Tanjore-Nellore coast, have been temporarily leased out to contractors pending the consolidation of work on the southern area.

37. The net profits from chanks during the year will be something over Rs. 20,000 *plus* receipts from the Rāmnād fishery which however, has only just begun. The arrangement with Messrs. Dutt & Son for the purchase of all the Tinnevelly and Tanjore chanks was renewed for five years at somewhat better rates. A contract has also been arranged at satisfactory prices for the purchase of the Rāmnād shells.

38. *Oil Chemist.*—By G.O. No. 3553, Revenue, dated 3rd December 1913, Mr. A. K. Menon was appointed temporarily as Oil Chemist. My reasons for supporting this appointment are stated at length in my letter read in the above Government Order. Mr Menon began work at the Indian Institute for Technical Research at Bangalore by kind permission of Dr. Morris Travers, F.R.S., but the institute closed for the vacation at the end of March before Mr. Menon was able to do more than begin work.

39. *Miscellaneous.*—Under this head comes an immense variety of work. Much of it has been done by Mr. V. Govindan, B.A., late Personal Assistant, but now Assistant Director. Being a Malabar man with a great knowledge of the people, their difficulties, wants and objections, commanding their confidence and with a philanthropic bent, he is able to undertake various difficult branches of work in addition to the work done by him as Personal Assistant. The inculcation of co-operation and thrift has been undertaken by him with the beginnings of success, though fisher-folk are very hard to move; co-operation is very desirable where the men are so ignorant, poor, and bound by custom, and especially where valuable goods, such as oil and guano, are produced in individually small quantities so that the petty manufacturer, always in want of money and seldom able to enter the open market direct with his small parcels of goods, falls a ready prey to the middlemen and broker, who is apt to take the bulk of the profits. A combination of a dozen or score of manufacturers would, of course, enable the men not only to borrow on easy terms but to bulk their produce and thus obtain the true market price. The Assistant Director has also undertaken the

work of setting up our *school* for fisher-folk in a building erected for the purpose in the Tānūr yard, close to the public road, and which also houses the hand-loom for net-making obtained during the year from England. The pupils are both boys and adults and are not merely taught the usual three "R's," but receive instruction and suggestions in technical and economic matters such as those of curing, of co-operation and thrift, etc., and it is found that the villagers readily come to listen ; the boys are also available for labour in the yard when additional hands are needed. The English *hand-loom* for net-making was considerably damaged *en route*, but the damages have been repaired, and it is hoped to work it to some purpose during the current year ; this matter has been placed entirely under the control of the Assistant Director who initiated the idea from his knowledge of the needs of the people in net-making and from seeing these looms when in England in 1912.

40. Considerable correspondence was held with the Collectors of Malabar and South Canara regarding the oil and guano factories which have so rapidly sprung up since there was among manufacturers a natural tendency to disregard or an ignorance of sanitary rules ; the Assistant Director visited about 45 factories and I also visited a number, with the result that a set of tentative rules, liable to alteration on greater experience, were drawn up and received the assent of one or both Collectors.

A "China" net as at Cochin and live car have just been put up by the Assistant Director at Beypore, but we have yet to gain experience as to their working.

41. The disposal of the produce of the Tānūr yard and Calicut cannery gave a great deal of work in the calculation of costs, in the consideration of the best methods of marketing, and in ascertaining public tastes. Four jails wrote for supplies of dried fish, but Vellore and Salem shortly dropped out ; Trichinopoly and Coimbatore, however, continue to take supplies. A stall was opened at Moore Market for the sale of canned and cured goods, and has made known these products to a section of the public ; it was found that curried sardines were preferred by retail purchasers at the Moore Market while wholesale buyers, usually Europeans, who deal direct with the cannery, prefer plain (oil-less) sardines, mackerel and prawns. A notable order for canned goods was a large one recently made by the contractor of the

Wellington canteen. We have the advantage in this country and with the market that will take our goods, of not being bound by trade customs or a fixed and hide-bound public taste ; if the products are good and also cheap they will be readily bought, even if they are not in the precise form or with the appearance or flavour—perhaps the result of adulteration—required by, say, English customers ; our "sardines" might find a poor market amongst Europeans who have been accustomed to French sardines or even to Norwegian "sprats" put up in particular ways and in the familiar containers, just as it was found that American "sardines," though well packed and of excellent quality, could find no sale in Europe solely because of the difference in form and method. Our markets, however, have no "custom" in this matter, and only demand soundness and cheapness. But it will, I think, be found, certainly within the current year, that our goods are attractive in every way, and they are absolutely without adulteration, being "pure food" in every detail.

42. Towards the close of the year arrangements were made with the Travancore and Baroda States whereby two young men from each State will study pisciculture and curing work in our stations during the current year ; one has already arrived from Baroda to learn ostreiculture, etc., under Mr. Hornell.

43. After the fashion described in one of Esop's fables, two contradictory criticisms are frequently addressed to me ; the one supposes that Government is intending itself to develop a fishing industry by means of its own trawlers, curing yards, etc., and criticises it on these hypothetical grounds ; the other animadverts on the supposed delay in putting departmental products commercially on the market ; "Does Government intend to run factories to the injury of an existing trade ?" asks one ; "Why does not the department market a supply of tinned goods, smoked fish, etc., to meet the demand ?" cries the other.

The answer to the first is the often repeated negation ; there is no intention that Government goods or enterprise shall injure any industry or trade either existing or prospective. On the contrary, Government efforts are directed to improving the indigenous industry and to stimulate or even create where for various reasons the industry in various branches is non-existent ; such, for

instance, are its efforts to improve existing preservative methods, and its actual creation of a canning and an oil and guano industry.

The Government stations are purely experimental and instructional ; money, thought and time are freely expended in experiment, and the results of these experiments, when successful, are promulgated by all possible means. Meanwhile an expert staff is growing up which will supply—as it has begun to supply—men trained in our methods, and will thus gradually get rid of a grave difficulty found in introducing new industries, viz., the absence of skilled artisans. Moreover, a superior staff is being gradually formed which will be available to supervise private operations, and the stations will shortly be centres where instructors, inspectors, experts, foremen, etc., can be thoroughly trained. The stations are not commercial except for several reasons viz., (1) the need to get rid of the products of experiment which are necessarily numerous and costly ; the canning experiments already number nearly 700, and each experiment may involve hundreds of tins, since it is impossible to test or create an industry by petty laboratory methods ; (2) the need to ascertain the public tastes and the true cost of goods by the time they are put into the consumer's hands. A third reason is to advertise successes, so that private enterprise may be induced to enter the field. The last two reasons coupled with the necessity for exhibiting a rapid up-to-date plant for imitation, are the warrant for the new departure at Beypore, which will, it is hoped, be at once a stimulation and a model to private enterprise. It is, in fact, the stimulation and education of private enterprise that are the aim of the department. It may be added that, except for a small European trade in canned goods, usually high-priced, there is no existing trade to injure.

The second criticism is answered by pointing out for the hundredth time that the department is experimental and the plant is experimental and petty but that, as mentioned above, the department is about to make a new advance in view to assist private enterprise ; in working out this new advance the new plant for the packing, etc., of sanitary, solderless tins will put considerable quantities of goods on the market. Meanwhile the cannery has sold during the current year a fair number of tins priced at several thousand rupees.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., Honorary Director of Fisheries.
Dated—Madras, the 18th June 1915.

I have the honour to submit my annual report for 1914–15.

2. The sanctioned and existing staff with their pay and qualifications are as follows:—

Name.	Designation.	Pay.	Academical qualifications.
		Director and Staff.	
		RS.	
1. Sir F. A. Nicholson, K.C.I.E.	Honorary Director.	...	...
2. Mr. V. Govindan, F.Z.S.	Assistant do.	400	B.A.
3. Mr. A. K. Menon, F.C.S.	Oil Chemist ...	250	B.A.
4 M. Jayaram Nayudu.	Sub-Assistant ...	50 (50—4—90)	B.A. (Had training in Medical College for three years.)
5. M Gulam Kadir ...	Do ...	50 (50—4—90)	F.A. (Had training in Medical College for two years.)
6. *Vacant*	Do.	50 (50—4—90)	Not yet appointed.
7. *Do.*	Do. ...	50 (50—4—90)	Do.
		Piscicultural Expert and Staff.	
1. Mr. H. C. Wilson ..	Piscicultural Expert.	950 (800—50—1,250)	...
2. *Vacant*	Assistant ...	150—10—250	Not yet appointed.
3. C. G. Chakrapani Ayyangar.	Sub-Assistant ...	80 (50—5—100)	B.A.
4. *Vacant*	Assistant Inspector.	30—4—50	Not yet appointed.
5. *Do.* ...	Do.	30—4—50	Do.
6. S. A. D'Silva ..	Do	25 (25—1—40)	...
		Marine Biologist and Assistant and Staff	
1. Mr. James Hornell, F.L.S.	Marine Biologist and Assistant.	950 (950—50—1,250)	..
2. S. T. Moses ...	Zoological Assistant.	100 (100—5—150)	M.A. (Zoology)
3. K. Narayana Ayyar.	Fish-farm Sub-Assistant.	50 (50—4—90)	B.A (Zoology). Has special training in Microtomy.
4. *Vacant*	Shell-fish Sub-Assistant.	50—4—90	Not yet appointed.
		Pearl and Chank Fisheries Staff.	
1. Mr. James Hornell, F.L.S.	Superintendent, P. and C.	...	(Vide entries above.)
2. J. A. Fernandez ...	Sub-Assistant ...	50 (50—5—100)	Matriculation.
3. S. Ramaswami Ayyangar.	Senior Operator.	50 (50—5—75)	Do.

3. The work was in general divided up as follows: Mr. H. C. Wilson as Piscicultural Expert was in charge of all piscicultural investigations, projects, and operations in inland waters, and also of the work of breeding and distributing larvicides; Mr. James Hornell, F.L.S., was in charge of all pearl and chank fisheries, of marine fish-farms including an oyster farm at Pulicat, and of various sea fishery investigations both practical and scientific; Mr. V. Govindan, B.A., as Assistant Director, assisted the Honorary Director in all west coast station matters, in office work, and in tours of enquiry and of inspection of private oil and guano factories while especially working on the social and economic problems of the fishing classes. The general work of the directorate and the detailed work of the west coast experimental stations formed my own share; I also visited England on fishery enquiries.

4. The principal operations in hand were as follows:—

(1) The work in curing, canning, oil and guano manufacture, etc., at the west coast experimental station;

(2) the Sunkesula fresh-water fish-farm;

(3) the hilsa hatchery;

(4) the stocking of tanks;

(5) the Colair lake project;

(6) the commencement of Ippur fish-farm in the Nellore district;

(7) the breeding and distribution of larvicidal fish;

(8) the acclimatization of tench on the plains;

(9) the conservation and development of trout in the upper Nilgiris;

(10) the conservation of the waters of the Bhavāni and Moyār on the lower slopes of the Nilgiris;

(11) the building of and early operations on the Tuticorin marine fish-farm;

(12) edible oyster cultivation at Pulicat;

(13) pearl and chank fishery work at Tuticorin and the Rāmnād coast;

(14) the pearl fishery at Tondi;

(15) the preparation of plans, etc., for the pearl oyster farm at Krūsadai near Pamban;

(16) soap-making from fish and other oils by the Oil Chemist at the west coast station;

(17) Miscellaneous, including—

(*a*) enquiries in England in 1914 for a master fisherman and mate, for hardened oils, for chank cutting plant, refrigerating plant, additional canning plant, etc.;

(*b*) work on the Colair lake fish-farming project;

(*c*) the consideration and publication of certain restrictive measures in fresh-water areas, streams and channels;

(*d*) investigations in various areas (Coorg, S. Kanara, the Palnis, etc.) of fresh water conditions and possibilities;

(*e*) the supply of trout ova from the Nilgiris to other waters;

(*f*) preparation of a list of tanks containing permanent waters;

(*g*) tours by all officers of scientific and practical investigation;

(*h*) scientific researches and the supply of specimens for educational purposes;

(*i*) the training of students from Baroda and Travancore in fishery operations in view to their appointment as fishery experts in their own States;

(*j*) the reorganization of the non-gazetted staff in view to an increase in numbers and status;

(*k*) bottle drift experiments in connection with pearl oyster operations;

(*l*) preparation of various statistics;

(*m*) work in connection with the social and economic condition of the fishing classes;

(*n*) consideration of the plans for a fishery steamer;

(*o*) consideration of the plans for the new Marine Aquarium and Biological Station;

(*p*) feeding cattle with dried fish;

(*q*) correspondence with British canning firms;

(*r*) refrigeration;

(*s*) issue of bulletins.

These matters are dealt with below.

West Coast Experimental Station.

5. The west coast experimental station was run by myself and the Assistant Director on the same lines as in the previous year, but a Sub-Assistant was appointed late in the year to take charge of the Tānūr curing yard, and another to the cannery ; these young men are under training. A student from Baroda and another from Travancore were also admitted to training for official work in their own States and did very well ; a young man from a South Kanara curing factory was also admitted as an unpaid student.

The year was extremely unfavourable, worse than any recent year ; there were no shoals of catfish from which such large supplies of food and money are usually obtained, few large fish, extremely few mackerel, and an extraordinary shortage of sardines, which, moreover, contained very little fat and that only for a minimum period ; the oil and guano operations were practically confined to November and those only on very few occasions, so that the station was able to supply only 250 gallons of fine oil to the Government Cawnpore Leather Factory instead of 1,000, and a 10-ton guano contract was, with difficulty, carried out. These unfavourable conditions were general all along the coast, and oil and guano factories were either wholly or largely idle and forward contractors experienced heavy losses ; the sea beaches were practically devoid of the usual masses of sardines drying as fish manure.

Some items of the work of the Tānūr yard are shown in Appendix II, but it is to be noted (1) that the year was very unfavourable, (2) that the yard is experimental and not commercial so that a good deal of money is necessarily expended without a return in profits, (3) that the staff, being Government employees, is necessarily kept on throughout the year and for every day in the year, whether there is work or not.

It was found impossible to induce Ratnagiri fishermen to bring their boats to Beypore, so that we were deprived of the cold weather catches of large fish which we obtained at Cannanore through these men. No real deep-sea work was possible.

6. *Curing.*—No new departures were made except in the construction of a new drier and in improving

the cure of prawns by the process described in last year's report; these are now well established as an excellent product for which there is a large demand. In round figures 5 lb. of prawns straight from the sea make 1 lb. of shelled, semi-dried prawns which will keep for many months and when slightly soaked are an excellent substitute for fresh prawns.

Experimental work in pilchardizing fat sardines, as mentioned in last year's report, was necessarily impossible, owing to lack of fish. For similar reasons the pickling of mackerel and other fish either in salt only, or in salt, vinegar, etc., could not be dealt with; the experiments stand over till next season.

Only one Jail (Coimbatore) continued to take dried fish from the yard, but new terms have now been arranged and other jails will probably take our fish.

7. *Oil and guano.*—As stated above, the year was extremely unfortunate and very little was done. A new shed with two large boiling pans on a new model (one worked by steam) were built and arrangements improved for obtaining fine oil and preventing rancidity; these will be tested more completely next season under the advice and supervision of the oil chemist. Samples of fine oil were sent to England for examination by hardening experts, and to others for medicinal use, while the lower grades and stearine were made into soap; see paragraph 43 below.

There were 211 private oil and guano factories at work or in existence on the west coast during the year under report.

8. *Canning.*—The manufacture was considerably developed in quantity but the recipes used were practically those adopted last year as standards and, to judge by the demand, are highly appreciated. Above 30,000 cans of all sorts were packed during the year, mainly of sardines (plain, curried, and in oil) 13,020, of mackerel (plain and marinated) 8,676, whole prawns 2,905, prawn paste 4,806, and smoked mackerel paste 930. Of these, together with the balance in hand on 1st April 1914, 29,108 cans were sold to the public for Rs. 7,298, being an average of Rs. 3 per dozen. To judge by repeat orders and other evidence, this experimental work has been highly successful, while from the numerous

complaints—almost the only ones—that orders were not complied with (from temporary lack of stock), there is obviously a large unsatisfied market for pure and cheap goods manufactured on a commercial and not on an experimental scale.

During the year the new cannery at Beypore was put up ; this provides good accommodation for canning, refrigeration and other preserving processes and for storage. The new canning plant produces solid-drawn cans, the bodies of which are struck by a drawing press from the flat ; the covers are secured to the body by "double seaming," the flanges of the body and cover being jointly turned over with the interposition of a composition band between them ; this makes an air-tight joint. It will be noticed that this method produces a can which is not only free from solder, but has only one seam instead of three as in the ordinary soldered can hence much less chance of spoilage. Moreover, the cans can be struck as fast as the press will work, and 50 perfect bodies have been struck in five minutes ; this immensely increases the potential output, and the cannery will no longer be limited by the capacity of its solderers who seldom solder more than 150 cans each per day. The new cannery was not actually at work during the year.

It has been proved during the year that sardines in oil are all the better for long storage ; cans of 1913 gave excellent gustatory results. Moreover, the oil used matters the less as the age increases, since the blended flavour of fish, oil and spice covers up any characteristic flavour of the oil ; refined cotton seed-oil gave as good results as olive-oil, while sardines in fine sardine-oil were generally preferred to any as being richer in flavour.

Experiments were recently tried with the greatest success in preventing the slight discoloration of prawns when canned ; the new method, not yet in practical use, involves some technical difficulties as regards the container and slight extra cost but this can be got over ; the fish under experiment completely preserved their natural brilliance of colour.

9. *Refrigeration.*—Owing to delays in building and the want of refrigerating experts, the new plant for fish-freezing after the Henderson method (see previous

report) was not put in action ; it is, however, now in place and will shortly be worked.

Fresh Water Pisciculture.

10. Mr. Wilson, Piscicultural Expert, remained in charge of these operations, which involve an immensity of touring and planning. The chief operations undertaken are described by Mr. Wilson in the following extract from his report :—

11. *Sunkesula fish-farm.*—The general work at the farm progressed satisfactorily and a large head of fish was secured and kept in the several farm ponds for stocking purposes ; but unfortunately, owing to the breaching of Tangadencha tank three times, the stocking of Kurnool-Cuddapah canal was not possible for want of sufficient water and hence only the first 20 miles was stocked. It may, however, be remarked that the breaching of the Tangadencha tank will have a most deleterious effect on the fishery of the canal for a few years to come. This tank, which never ran dry, contained a lot of good breeders, and the canal was replenished every year with fish from this source. To make good this loss will mean the re-stocking of Tangadencha from Sunkesula for many years. Many thousands of murrel, fry, etc., were however removed from the farm and turned out into the Edurur swamp for growing purposes.

The new and valuable larvicide *Polyacanthus cupanus* referred to in my last year's annual report have since bred in the farm. A portion of the Hindri river close to the Kurnool Collector's bungalow and the Markapur tank were stocked with this useful larvicide.

Another interesting item of work done at the farm was the introduction of tench (*Tinca vulgaris*). A small consignment of tench and English carp were brought from the Nilgiris and turned out into the breeding ponds.

Live-fish market.—This was opened in Kurnool and live fish were sold to the public at three annas per pound fetching a sum of Rs. 371 to this department during the year. The market was supplied with fish from the fish farm.

12. *Hilsa hatchery.*—During the year under report my Sub-Assistant went to the Lower Anicut to attend to this. He waited for several days and though almost all female hilsa caught were in a gravid state not a single ripe one could be had. As the water in the river went low and there were no further runs of fish, the hatchery work was closed for the year.

13. *Stocking of tanks.*—As mentioned in paragraph 11 supra it was impossible to stock the whole of the Kurnool-Cuddapah canal owing to the breaching of the Tangadencha tank.

Daroji tank in the Bellary district and the Markapur tank in the Kurnool district were stocked with fish from the farm in September and October last respectively ; the latter tank, however, was again stocked in December with carp and mosquito larvicides.

Besides the above two tanks another tank which holds permanent water, viz., Peddamentrala in Markapur taluk of the Kurnool district was also stocked.

Barur and Penukondapuram tanks were not stocked during the year under report, but I hope will be stocked during the current year.

14. *The Colair Lake project.*—As mentioned in my last year's report the submission of detailed estimates called for in G.O. No. 61, Revenue, dated the 6th January 1913, is still being delayed owing to the existence of stake nets and fixed engines. When my new Assistant is appointed he will be put on this work; after a thorough investigation, proposals for the removal of these nets under G.O. No. 1905, Revenue, dated 2nd July 1914, will be drawn up and submitted to Government for necessary action.

15. *The Ippur Fish-farm in Nellore.*—The site selected is in the bed of Ippur tank about 11 miles from Venkatachalam station on the Madras and Southern Mahratta line. The water is supplied by an open channel from Survapalli tank and the Public Works Department records show that the water-supply in this tank, if carefully guarded, should not fail to supply the fishery excepting in years of great drought.

The construction of a well has been provided for and a small pumping plant to insure against the above danger and for other necessary work.

The fishing rights of this and Puduparti tank adjoining have been handed over to this department and the small rentals amounting to only a few rupees will be paid as compensation to the Nellore District Board. The plans of the fishery and buildings have been perused by the Public Works Department and the works sanctioned by Government in G.O. No. 2997, dated 14th October 1914.

The work is now in the hands of the Executive Engineer of Nellore and will be completed this year.

16. *Breeding and distribution of larvicidal fish.*—A good deal of Mr. Wilson's time and energy were spent on this matter; not only were further experiments conducted at Sunkesula, but the new Ippur farm is specially devised to provide a supply of larvicidal fish for distribution to municipalities, etc.

Mr. Wilson reports as follows:—

"In July I inspected several wells in Tondiyarpet, Madras, with Captain Hodgson, I.M.S., in connection with the Anti-malarial operations. Many of the wells visited that had been stocked with larvicides, were examined and absolutely devoid of mosquito larvæ.

The danger of the present method of stocking with fish larvicides was pointed out to Captain Hodgson, viz., the liability of introducing eggs of predaceous fish with the larvicides.

The present system of gathering the small fish from surrounding ponds is an exceedingly bad method and it is almost a certainty that eggs of predaceous fish, especially the floating eggs of the *Ophiocephalidæ* family, will be accidentally carried.

In some of the wells visited which had been already stocked, we found the small fish larvicides had all disappeared and it was evident that some predaceous fish had been introduced.

On completion of the larvicide farm at Nellore the small fish can be sent for stocking purposes free of all this danger."

17. *Acclimatization of tench.*—With reference to G.O. No. 1601, Revenue, dated 3rd June 1914, sanctioning the above scheme, a consignment of tench was brought from the Nilgiris in February last and turned out into Jeejur tank and another small tank close to Mattigiri near Hosur ; as mentioned under Sunkesula fish farm a small consignment of tench was put in one of the ponds of the fish farm at Sunkesula. The result of the experiment will be reported to Government in due course.

18. *Trout on the Nilgiris.*—In May the streams of the Nilgiris were inspected to decide the opening date of trout fishing and the same month the following rivers were restocked with large trout from the reserve stream in Parson's valley, viz., Pykara (upper reaches), Krurmund, Mekod below falls, Kundah river below McIver's bund, and Billithada Halla.

In September a valuable consignment of live fish food was brought from the Moyār river near Torapalli to the fish ponds and river at Pykara.

The same month the following new streams were stocked with trout, viz., Tiah shola stream (Kondas) waterfall streams, Piermade stream, and Bangi tappal stream.

The supply of eggs at the Avalanche hatchery was fairly good and trout were kept for transhipment to the Travancore ranges, etc. The rivers are fully stocked with trout and some very large fish have been seen.

A consignment of tench was sent to Wellington to restock the lake.

19. *Conservation of Bhavāni and Moyār rivers.*—The usual conservancy precautions were taken. As regards the Cauvery into which these rivers flow Mr. Wilson writes as follows :—

"During the year under report the Cauvery and the Coleroon fisheries have been taken over by Government paying the district boards concerned a fixed annual compensation. To improve this fishery it is absolutely necessary to prevent the wholesale indiscriminate slaughter of fish which takes place during the annual fish drive in the Cauvery near Hoginkal (Salem district) as well as dynamiting, etc. With the help of the Collector of the district as well as the District Forest Officer the annual fish drive has been put an end to during the last four or five years, besides dynamiting as well as other illegal methods of capturing fish. Through the co-operation of the District Forest Officer, Salem, all fishing licenses will be issued for a nominal fee for capturing fish in the river within the forest boundary, and the size of mesh of the nets used will also be regulated."

20. *Miscellaneous—Palni hill streams.*—With reference to G.O. Mis. No. 359, Revenue, dated 3rd February 1914, the Palni hill

streams and the new reservoirs at Kodaikanal and Berijam, etc., were examined and reported on as to their suitability for the introduction of trout. Government have approved of the scheme and a consignment of trout will be sent in May.

Examination of South Kanara waters.—In G.O. Mis. No. 1543, Revenue, dated the 28th May 1914, I was requested by Government to examine the above waters and to suggest the methods to improve their fisheries.

Large sections of the waters of this most interesting district (from a piscicultural point of view) have been inspected when at their lowest levels and a full report will be submitted shortly.

The following rivers were visited during the inspection: Charvattur, Payasuvati or Chandragiri, Adkastala, Netravati and its tributaries.

Most of these splendid rivers were found to be so severely poached by means of fixed engines, etc., that it will take many years of strict conservancy and stocking to bring them back to anything like their full fish-bearing capacity. It will be necessary to construct a fishery for the restocking of these most valuable waters, and possible sites were visited on the upper reaches of the more important streams. The most promising site for this work was found on the Ancel river near Neriya which is a tributary of the Netravati.

Full particulars of this proposed fishery will be submitted in a separate report after reinspection of the selected site during the monsoon season.

Coorg.—Having inspected all the more important rivers of Coorg a report is being submitted to the Chief Commissioner with suggestions for conservation and the possibilities of introduction of new species.

During the year under report correspondence with the Public Works Department has enabled us to compile a list of all the tanks in this Presidency which contain more or less permanent water. These will be inspected as time permits and methods adopted to improve their fisheries and take them over to our department.

Many municipalities were advised as to the best fish larvicides to stock their waters with, but the request of some to be supplied with a stock of larvicides could not be complied with, until the Ippur fish farm is working.

There were also numerous miscellaneous items such as correspondence with China and Java relating to the introduction of gourami, which should have practical results during the current year, correspondence initiated by the Government of Hongkong on angling matters, the publication of a note on the treatment of swamps, ponds, etc., from an anti-malarial point of view, etc.

Marine Pisciculture and Other Work.

21. *Tuticorin Fish-farm.*—At present we have—for various reasons—no marine hatcheries; the present need for them is not proved, and no staff is as yet available. But we are attempting to develop the usefulness

of our immense backwaters all of which open to the sea, and the Tuticorin fish-farm is the earliest systematized attempt to produce free swimming fish under controlled conditions. Mr. Hornell, as Marine Assistant, devised this farm in a lagoon at Tuticorin and built it during the year under report; he writes as follows :—

"The Tuticorin fish-farm was completed in January 1915 and stocked with mullet, whiting *(Sillago sihama)* and other quick growing backwater fishes. Hardly had this been done when unseasonable and exceptionally heavy rainfall occurred throughout the Tinnevelly district entailing in the river valleys very serious losses wherein the fish-farm unfortunately participated to the full. A considerable portion of the palisading was damaged and could not be repaired till the floods subsided. The fish fry were scattered and stocking had to be undertaken a second time in March; we cannot therefore expect growth to be so satisfactory or the stock to be so large as it otherwise would have been had normal conditions prevailed in January. The work done has, nevertheless, already added largely to our knowledge of the fauna of the lagoon and of the life histories of several of its more important constituents. A very satisfactory feature is the great abundance of two of our most valuable Indian prawns; not only do these species grow to a large size and form excellent eating, they also constitute a valuable bait for the line fishermen. These men for years past have been handicapped by a shortage of this bait, so when I found that prawns were thriving greatly in the fish-farm, it appeared obviously sounder economically to exploit this resource specifically for the benefit of these men than to dispose of the catches to the general public as food. Accordingly special store baskets were devised in which the catches made during each day are stored till the early morning of the succeeding day when the line fishermen come for their supply. On most days their demand is greater than the supply; this I hope to put right next season when more normal weather conditions may be expected to prevail than was the case this year.

"The line fishermen greatly appreciate this boon of bait supply and storage. Hitherto it has been a common occurrence for them to be delayed unduly in the mornings as the lack of storage facilities meant that they had to await the actual daily capture of prawns before they could go to sea; I have seen men sitting on the shore till 9 A.M. waiting for the prawners to catch a sufficiency of bait. Now they can usually get to sea by 6 A.M. as all they have to do is to go to the prawn store and buy what quantity they desire."

22. *Edible oyster culture.*—Growth of the stock on the beds at Pulicat proceeded most satisfactorily throughout 1914, and at the beginning of January 1915, the oysters had recovered from the set back they annually receive during the ordinary rainy season of October and November. Unfortunately the exceptional and heavy rains which occurred towards the end of January and which, as already mentioned, occasioned ill-effects in the Tuticorin fish-farm, were equally well marked at Pulicat and this second flood of fresh water threw the oysters back two months in condition so much so that sales had to be

suspended temporarily during February and March. Low salinity continued for an unduly long period after the floods subsided and indicates that a backwater with a relatively small area is preferable for oyster culture to one of much greater extent whenever the sea-mouth of the latter is restricted in size.

Prospects for the coming year are again good, but pending the erection of the proposed Biological Station and Aquarium at Madras and the provision therein of conditioning tanks for oysters, no great extension of sales can be hoped for, as recent railway time-table rearrangements have been retrograde in regard to the Ennore service, entailing serious distribution difficulties.

23. *Other work.*—This heading comprises a great deal of work of which the main items are reported on by Mr. Hornell as follows:—

" *Technical instruction in fishery science.*—Two students sent by the Baroda and Travancore Governments were given courses of practical instruction. They are now employed by their respective Governments as fishery experts and I continue to give them advice unofficially from time to time.

" *The supply of biological specimens* to educational and scientific institutions was commenced; specimens were sent to the Cochin Museum. the Oceanographic Museum at Monaco, the Christian College, Madras, and others. Considerable extension of this section is expected in 1915–16. The sum of Rs. 56–13–0 was received for the specimens supplied and was duly paid into the treasury.

" *Current and drift investigations* were continued; 2,850 bottles were liberated; sufficient results have now been obtained to permit of deductions being made. A report is in preparation.

" *Statistics of the Tuticorin fishing industry* have been tabulated in great detail for the past 3½ years. These comparative statistics exhibit clearly the large monetary value of the industry and the fluctuations due to seasonal changes; they also throw a flood of new light on the seasonal abundance of the principal food fishes on the east coast and their relative importance.

" *Sardine investigation* was continued with a view to determine the factors governing sardine abundance in inshore waters and other vitally important facts in their habits and life history. Work to this end was carried on at Tuticorin, Cannanore and Beypore.

" *The economic position of the fishing population* in Tinnevelly and Rāmnād districts received attention and proposals have been made to assist them by means of loans to buy boats and gear. Further information has recently been obtained pointing to the urgent need for assistance if development is to proceed satisfactorily.

" *Mechanical chank fishing.*—As experiments in dredging and trawling chanks have not proved satisfactory, attention was given during the year to the possibility of designing a simple form of submarine boat to be used in fishing chanks and pearl oysters. Success depends upon the evolution of a sufficiently simple and inexpensive design.

" *Beche-de-mer fishery.*—Several of the species of Holothuria (Sea-cucumbers) best esteemed by the Chinese in the preparation of

their great delicacy of beche-de-mer or trepang have been found, in the course of the prosecution of the Rāmnād Chank Fishery, to be abundant in Palk Bay; it appears that they can be fished profitably together with chanks and I am now preparing a proposal whereby this department may take up the working of this industry, in order, by experiment, to ascertain the best methods of preparation and thereby to set this industry, which has potential value, upon a stable footing. By working this industry in conjunction with the chank industry, the divers will be able to make better wages and so be rendered more content and more active in the prosecution of the chank fishery. The divers have difficulty in finding any market whatever for beche-de-mer and the industry is practically dead at the present moment, hence this is a favourable time to begin operations; such action would be welcomed with gratitude by the divers."

Pearl and Chank Fishery Work.

24. As usual this branch will be reported on in detail separately. In this matter Mr. Hornell writes briefly for the present report as follows:—

"A pearl fishery was held at Tondi in August and September 1914 after prolonged inspection of the pearl banks off Tondi and Karangadu, discovered in the preceding April. This fishery is epoch-making in that it is the first ever held in Palk Bay. Full details are given in G.O. No. 633, dated 10th March 1915. The net profit made amounts to Rs. 3,496–11–9 inclusive of the amount to be paid this year by the lessee of the right to fish the oysters left unfished.

"The life history of the pearl oyster received much attention. Large larvæ already assuming the adult form were taken in the tow-net in April and it has been thus shown that the dispersal period may be much more prolonged than we know. The Palk Bay beds appear to constitute the natural breeding stock whence the Ceylon and Tuticorin beds are periodically replenished. Palk Bay may be considered the motherland of the Gulf of Mannar pearl oysters. A new potential pearl-inducing parasite was found and has been described in a paper upon the Tondi Pearl Fishery read before the 2nd Indian Science Congress held at Madras in January 1915.

"No inspection of pearl banks in the Gulf of Mannar was possible last season owing to the Inspection Schooner "Lady Nicholson" having been requisitioned by the Port authorities at Madras. So far as can be ascertained, no spat-fall has occurred on the Tinnevelly banks during the past year.

"*Pearl-inducement.*—In anticipation of the early construction of the Pearl Laboratory at Pamban, a senior operator has been appointed and is now undergoing preliminary training in technical methods. The opportunity of a pearl fishery in Palk Bay in 1914, enabled a number of new experiments in pearl-inducement to be commenced; the requisitioning of the inspection schooner for war service at Madras brought these to an untimely end and for the present they are necessarily in abeyance."

Chank fisheries.—This department now controls the chank fisheries along the whole coast between Cape Comorin and Chingleput, which for convenience' sake are named the Tuticorin, Rāmnād, and Coromandel fisheries. Mr. Hornell writes as follows :—

"The Tuticorin Chank Fishery for the year ending 30th June 1914 is given in detail in G.O. No. 202, dated 21st January 1915. The total number of shells paid for was 232,504 and the net proceeds amounted to Rs. 18,784–3–9. The 1914–15 season just ended will be less productive owing to the interruption caused by a divers' strike which lasted from 20th November 1914 to 22nd March 1915, whereby the best part of the season was lost. The number of full-sized shells fished now in stock and ready for delivery is 129,437.

"The Coromandel Chank Fisheries brought in Rs. 1,513–5–4 for 1914–15. The South Arcot lease expiring on 31st March 1915, tenders for a further term were called for and an enhanced rate was obtained, viz., Rs. 900 per annum for three years from 1st April 1915 as against Rs. 516–10–8 per annum for the term ended. The revenue from this coast steadily improves. The lessee again complains of loss sustained due to the smuggling of shells into French territory.

"The Rāmnād Chank Fishery proved difficult to organize during the first year owing partly to lack of sufficient acquaintance with local conditions and largely to the difficulties put in our way by the chank merchants of Kilakarai who are jealous of the new departure. Since July 1914 these difficulties have been largely moderated as an intimate knowledge of local conditions has been obtained, and the opposition to some extent broken down though this may be temporary only. As a result a very satisfactory fishery was held at Rameswaram and thanks largely to the loyal example set by two boats' crews of divers recruited at Kilakarai and the fair treatment and good pay given, a considerable number of other divers attended. The total catch for the current season already amounts to 117,172 at Rameswaram as against 8,218 last year; 31,564 at Tirupalakudi, Vedalai, etc., against 4,978 last year; 17,584 at Kilakarai against 427 last year.

"Excellent relations have been formed and maintained with the Kilakarai men, and were these divers free from the trammels of the pernicious advance system wherein the merchants and boatowners have enmeshed them we should have the whole diving population of Kilakarai at our call. As it is, many of the men who have worked for us at Rameswaram fear persecution for so doing and ask for protection against this if it occur."

25. *The Krūsadai pearl oyster farm.*—The general proposals for the establishment of a pearl oyster farm and a subsidiary marine biological station in the island of Krūsadai close to Pamban and for acquiring the island for the purpose were sanctioned in January 1915. The detailed plans and estimates are under preparation in the

Public Works Department and these will be submitted to Government shortly.

26. *Chank bangle cutting.*—This formed the subject of enquiry in previous years and in 1912 when in England I obtained the aid of a Birmingham firm in cutting these hard porcellaneous shells. The experiments, as well as other enquiries by Mr. Hornell, proved useless, but in 1914 I consulted Dr. Wyndham Dunstan, Director of the Imperial Institute, London, who at once interested himself in the matter. The result is mentioned by Mr. Hornell in the following remarks, and it is now quite possible that success in rapid machine cutting may be obtained, and a local industry developed.

Enquiries with a view to obtain a satisfactory cheap and effective machine saw to slice chank shells into working section for the shell-bangle worker, were continued during the year and now promise to be successful at last. Both the Director of the Imperial Institute and Mr. Pierce, the Superintendent of the Public Works Workshops have been good enough to give their assistance, and the former recently supplied samples of chank sections cut by a machine saw which operates under water. The price of the saw and fittings is quoted at £18 and if the answer to some further queries which have been transmitted to the Director be satisfactory, it will then be desirable to obtain a sample machine and carry out working experiments in Madras or Tuticorin to ascertain what modifications be necessary to fit it for employment by small manufacturers who have not command of steam or electric power.

Miscellaneous.

27. Of the items mentioned under this head in paragraph 4 *supra* those marked (*b*), (*d*), (*e*), (*f*), (*g*), (*h*), (*k*) have already been touched on in paragraphs 14, 18, 20, and 23; the others will now be briefly mentioned.

28. (*a*) *Master fisherman and mate.*—This matter was alluded to in paragraph 20 of last year's report. The necessity for a master-fisherman to take vessels into the deep sea, to use and teach the use of new nets and methods, to keep the seagoing staff up to their work, to conduct experimental fishing intelligently, thoroughly and conscientiously, and to report results accurately, has

been abundantly proved by the experience of past years. Accordingly sanction was given by Government in G.O. No. 822, dated 21st March 1912, for the appointment of such a man ; various difficulties, however, prevented his appointment. But in June 1914 I visited Aberdeen and several other fishery centres in view to the recruitment of a master-fisherman together with a mate additionally sanctioned by Government Memorandum No. 1811-A 13-15, Revenue, dated 2nd June 1914. By the courtesy of Messrs. Richard Irvin & Sons (Aberdeen) two excellent men were selected on the terms sanctioned, but the outbreak of war cut short the negotiations as both men were trained mine-sweepers and were taken by the Admiralty ; it seemed useless to negotiate for others under war circumstances. The matter therefore stands over, but as the new fishery steamer has not yet been sanctioned, this is of less account, since a good fishery boat will be necessary to give the men full scope and obtain true and complete results.

29. (*c*) *Restrictive measures.*—As mentioned in paragraph 14, large fresh-water projects are delayed or impossible because of the unrestricted use, or rather abuse, by fishermen of stake nets and fixed engines. The matter will require very wide enquiry and very careful handling, but a beginning was made as per G.O. No. 1157, Revenue, dated 15th May 1915. The matter is also briefly touched on in the quotations contained in paragraphs 19 and 20 *supra*.

30. (*i*) *Training of students.*—During the year two students from Baroda and two from Travancore arrived for such training as could be given them, in view to their subsequent employment in their respective States—one from each State was to study pisciculture, and one to learn the principles and art of fish-curing, canning, etc. The young men selected proved to be capable and diligent, and all have since been appointed to fishery posts in their respective States, but they will probably return next season for further study. The pisciculturists will also study curing, and the curers will study pisciculture so that they may be, more or less, all round men.

This department is, of course, not yet prepared for regular educational work ; it cannot be till we have the new Biological Station and Aquarium at Madras and until

our own researches are more complete, but what could be done was done, and the additional labour was often a pleasure because the men were diligent and respective.

In November 1914, the Director of Public Instruction enquired whether this department could receive a few trained teachers in order that they might get a general knowledge of the aims and methods of the department in view to their subsequent work in teaching rural science in Elementary Schools. Although we are not prepared for such working it has been arranged that the Assistant Director shall take charge of such students; they will also be shown the work of the Piscicultural Expert and Marine Assistant.

31. (*j*) *Reorganization of the non-gazetted staff.*—By G.O. No. 2348, Revenue, dated the 14th August 1914, this was considerably strengthened and improved in numbers, pay and status. The Piscicultural Expert received a separate establishment, including an Assistant who will have to be Mr. Wilson's under-study in fresh water pisciculture and operations generally; it has not yet been possible to find a suitable man on the pay sanctioned by Government. On the marine side a Zoological Assistant on Rs. 100—5—150, two additional sub-assistants, and a senior operator on Rs. 50—5—75 were sanctioned; the first named, who is to work in connection with the projected Biological Station and Aquarium at Madras, was appointed in advance so as to be trained under and to assist Mr. Hornell; the two sub-assistants are to take charge of fish-farm and shell-fish culture operations, respectively, while the Senior Operator will work on the Krūsadai pearl oyster farm and is being trained accordingly. For the Director's immediate staff four sub-assistants were sanctioned for the numerous operations in hand or in immediate view, but only two have, as yet, been appointed, one for the curing and oil and guano yard at Tānūr, and the other for the cannery. The pay and qualifications of the new men will be found in the list in paragraph 3.

When this whole staff has been properly trained the department will be on the way to carry out a considerable amount of practical and scientific work. The clerical and account staff was simultaneously improved in pay and prospects.

32. (*l*) *Statistics.*—Under Government Orders the department began to compile fishery statistics. Mr. Hornell has for several years done so for his own station (Tuticorin) as regards fish and fishing, but the statistics required by Government are more far-reaching. A beginning has been made in utilizing the statistics found in the standing note-books of the 119 Government fish-curing yards (i.e., bonded yards where duty-free salt is issued to the curers who are left mainly to their own curing methods) and these are now being compiled, supplemented, and commented on by the Assistant Director and will shortly be submitted to Government. As the department has absolutely no staff for collecting statistics, these will necessarily be imperfect; but may serve as a basis and should give some idea of the fishing population, of their boats and fishing gear, and of the fish obtained at various seasons and localities. I am also collating the answers to questionnaires issued to various authorities (Revenue officers, Medical and Sanitary officers, and Municipal authorities) some years ago; these should give some knowledge of fishery conditions and of fish as popularly used for food.

33. (*m*) *Socio-economic work.*—This is almost entirely in the hands of the Assistant Director Mr. V. Govindan, who was not only deeply interested in such work (especially among the "depressed" classes) before he joined the department, but is otherwise well fitted for it, especially on the west coast. During his work under me on the west coast he has been not merely collecting data for a complete paper on the condition of the fisher-folk on the west coast—which is his own country—but has constantly discussed economic matters with groups of people in various localities. He writes as follows:—

"After four years of constant talk and persuasion I have succeeded in starting a co-operative society among the fishermen of Tānūr. The society was registered about the end of March and arrangements are being made to commence business. Fifty of the leading fishermen who own boats and nets have already joined the society and paid the first call on their shares. This is a co-operative nidhi and each shareholder has to pay a sum of Rs. 50 within 25 months by instalments of Rs. 2 per month, and thus the members have to create a capital by their own contributions. As the maximum number of shares is 200, this society will have a capital of

Rs. 10,000 in two years' time provided the fishing season is good, and with this large amount it will be easy enough to put a stop to the sowcar's greedy transactions in the place. Most of these people will require only short term loans, and it is not unlikely that they will have money on hand to lend to other societies or banks.

" Fishermen at Quilandi, Tellicherry, and some other places are being persuaded to organize similar societies, and as soon as the successful working of the Tānūr society comes to their knowledge it may be presumed that they will also come forward to form societies in their respective villages.

" A society for the special benefit of the owners of fish-oil and guano factories has also been suggested and nearly a dozen owners of such factories in South Canara have been considering the matter, but owing to the last two fishing seasons being unfavourable nothing practical has come out of the discussions.

" In a certain fishing village which is situated near the mouth of a large river there is scope for a co-operative fisheries society. The right of fishing in this locality is auctioned by Government and is usually purchased by some one who does not belong to the fishing community. Last year it was purchased by a man who had also the license for selling toddy. This man not only collected so much money from each fisherman who fished in these waters but also made it a condition that they should patronise only his toddy shop, and in order to make it doubly secure he made each fisherman to deposit a sum of Rs. 5 with him. The sum so deposited was more than what he had to pay as the license fee of his toddy shop. Moreover, such farmers of the fishing rights give a lot of trouble to the fishermen and drag them to the courts. It will be a great boon to the fishermen if the right of fishing in this locality is given to them direct on condition that they organise a co-operative society and work on co-operative basis and pay the Government dues in a lump sum collected from each fisherman. This will not only benefit them pecuniarily but also free them from all petty worries and litigation. I spoke to some of the men when I visited the village but they could hardly understand what co-operation was, but some non-fishermen who overheard our conversation at once understood it and shook their head. I am sure a few more visits and talks will open their eyes in this matter. I understand that there are several other villages in the south where the conditions are similar and there is good scope for co-operation."

34. On the subject of intemperance, which is the curse of the fisherfolk, he makes the following remarks:—

" Besides the above mentioned tours I have inspected a number of oil and guano factories in Malabar and South Canara and on such occasions I have spoken to fisherfolk on various topics such as co-operation, education, improvement of their surroundings, thrift, and intemperance. In August last on a visit to Malpe, I spoke to several people about temperance and education of their children. Soon after I left the place there was a meeting of the elders of the Mogar caste on the occasion of a temple festival at Mulki and they discussed the

subject of temperance of which I had spoken to them at Malpe and they unanimously came to the conclusion that drinking should be prohibited among the members of the community. Accordingly all this caste people living in the two taluks of Udipi and Coondapoor gave up drink. The result was that the toddy shop vendors in the fishing villages began to feel the pinch and they sent up petitions to the district authorities about the fishermen's resolution to abstain from drink. The authorities could give them no help and they then got round some of the leaders of the fisher community and by underhand means tried to nullify the resolution. In some villages I am sorry to hear they have succeeded, but in most places the people have understood the spirit of the resolution and have not taken to drink again. I am certain that a few more meetings of the elders will ultimately win the day for temperance. A temperance society for the benefit of this people has been in existence in Mangalore during the last four years and branches of this society have been formed in various other villages and the membership has increased."

It was mentioned in my report of 1910–11 that some of the older fisherfolk themselves opposed the efforts of younger men to adopt temperance on the ground that drinking was customary and should be adhered to; the obstruction or rather the active efforts of the toddy shop vendors mentioned in the two paragraphs above can only be characterized by a word which is theological but not official. It is, however, of great interest to note the influence of caste panchayats in guiding special matters and that such influence can even withstand opposition.

The whole matter will be discussed and, I hope, practical recommendations made in the paper mentioned in paragraph 33 together with any commentary that may be necessary. The cognate matter of improving the financial position of the fishermen and curers, whether by Government loans or co-operative societies, etc., which has been under enquiry and discussion for years, is mentioned by Mr. Hornell (paragraph 26 supra) and by Mr. Govindan, and will be more fully discussed in a note now in hand submitting to Government a programme of future work based on the enquiries and operations of the past ten years.

35. *Primary school for fisher boys.*—This was mentioned in paragraph 39 of last year's report and has been continued during the year; the Assistant Director writes as follows:—

"There were 23 pupils in the rolls; in addition to elementary education they are being taught technical subjects such as carpentry,

preparation of twine and cotton for making nets, net mending. Application has been made to the Educational department to have this school recognized as a grant-in-aid institution. Some of the pupils have been engaged occasionally in the curing shed to assist in curing operations, and also sent out in the canœ carrier to buy fish in the sea for our yard. In order to teach them thrift—the want of which is the cause of everlasting indebtedness of the fishing community all along the coast, pupils of this school are being persuaded to make savings bank deposits in the local post office, and several boys above sixteen years of age have already opened such accounts."

The Government curing yard within which the school is situated, is often suddenly in need of extra hands when large quantities of sardines, prawns, etc., have to be dealt with, and the idea is that the boys shall work partly in the yard and partly in the school, and thus be doubly trained. Pictures of fisheries and fishery subjects are being utilized, and this method of visual instruction is about to be developed by means of further pictures and an optical lantern ; this will also attract adults.

36. (*n*) *Fishery steamer.*—The plans for this vessel were repeatedly discussed during the year both by a committee appointed by Government *ad hoc* and which included Commander Huddleston (Presidency Port Officer), and otherwise. The steamer is intended to be a full power trawler fitted both for trawling, drifting, and lining, with accommodation forward, possibly after the fashion of modern "destroyers," for a scientific and controlling staff and their work. She will also have a refrigerating plant and everything needed for thoroughly practical work in order that the question, at present unanswered, as to the fishery possibilities of the deep sea (that is, for this Presidency, everything outside 10 or 12 fathoms), may be fully examined and answered. In view of the very large and direct fishery work undertaken by various Colonial Governments, this is but a modest proposal. The matter has recently been referred to by Government to the India Office for consideration of the best plans and for an estimate of cost.

37. (*o*) *New Marine aquarium and Biological station.*—The plans were under the consideration of the Government Architect, and it is understood that they are in temporary abeyance pending the question of the architecture of future buildings on the Madras Marina. I need hardly again urge the importance of this

institution both as Fishery head-quarters and as a place of biological, educational, and economic research, and as a delightful resort for instructive recreation to the public.

38. (*p*) *Results of feeding cattle with dried fish.*—This was mentioned in paragraph 8 of last year's report. The results were published in the Pusa Agricultural Journal; apparently the experiments were successful but their commercial success depends on the price of the dried fish which is very irregular owing to the great uncertainties of the sardine shoals.

39. (*q*) *Correspondence with British canning firms.*—While in England in 1914 I circularised several canning firms at the end of July on the subject of establishing canning branches in this Presidency. Three replied, of whom one—a great firm—was not prepared to adopt the proposal but most courteously and voluntarily offered me any information or assistance I might require. Two firms favourably considered the matter, of whom one, which has been consistently courteous in admitting me to its cannery and giving me information, has sent a long and practical set of questions which have recently been answered; its representative will probably visit Madras next cold weather. My return to India on the declaration of war prevented visits to the several firms subsequent to my circular.

The establishment of local factories by great British firms would not only give an immense impetus to the business and to subsidiary industries, but would set up a definite standard of goods which would be of enormous advantage to the public and to the industry.

40. (*r*) *Refrigeration.*—Enquiries were also made while in London regarding the French Audiffren-Sangrun refrigerator; there are machines of this make in Government House, Madras, and the Pasteur Institute, Coonoor, etc., and it seems probable that machines of this type will be very suitable to Madras coastal requirements. Their great advantage is that they are absolutely self-contained and hermetically sealed (by welding), with the result that, on receipt of the machines, there is absolutely nothing to be done but to connect motive power to the driving pulley of the machine, and refrigeration begins. There are no intricate valves or parts, no charging with ammonia; the machine seems

absolutely fool-proof, and such that any person possessing an oil-engine or spare power can set one up at once; they are not dear and are made in very small sizes. For refrigerating or hard freezing they seem to be very desirable where labour is unskilled.

41. (*s*) *Issue of bulletins.*—Only one Bulletin, No. 8 was in active preparation during the year, and will shortly be issued; Bulletin No. I—never issued—is also in the Press, and Bulletin III ("Preservation and Cure of Fish") was partly revised for early re-issue.

42. Besides the above miscellaneous items there was constant ordinary work both experimental, clerical, and account; e.g., experiments with a small beam-trawl, live cages, line fishing, the China net, net making, artificial drying, smoking, etc., which need not be detailed but which took up time, energy and money. One interesting item was a visit to all the department's centres of work by Mr. T. Southwell, A.R.C.SC., F.L.S., F.Z.S., Deputy Director of Fisheries, Bengal.

Among the correspondence may be noted letters from and to the Salt department relative (*a*) to the amount of salt that should be issued in the south-west monsoon, (*b*) the amount of salt for particular classes of cure, (*c*) the propriety of issued duty free salt for the Colombo pickle cure.

Other important correspondence related to the hardening of fish oils by hydrogenation, while a leading Madras firm enquired as to the supply of fish on the east coast in view to the possibility of obtaining a regular supply of fish oil for soap making or edible purposes; to this firm I was unable to give much hope. Correspondence was also held with the Salt department and with the Geological Survey of India in hopes of obtaining potash (for fish-oil soaps, etc.) from the bittern or from possible potassic deposits, but there appears to be no present available source in India of the potash so greatly needed in the soap and other industries; seaweed (kelp) is not available on Madras coasts, and potash cannot, at present, be commercially won from our abundant potash-felspar (orthoclase, often used as road metal in Erode and Namakkal taluks, etc.), though I note that the United States Potash Company with a capital of £50,000,

has just been formed to extract potash from Maryland felspar by a process said to be commercially profitable.

Oil Chemist's Work.

43. This was practically a new branch and is a very interesting and important departure, both in itself and its probable developments. The Oil Chemist was employed on various analyses and experiments on fish oils and soaps both at the Indian Research Institute, Bangalore, and, by the courtesy of the authorities, at the Agricultural College, Coimbatore; these need not be detailed though important to the department and hereafter to the industry. The work at Tānūr from September was disappointingly cut short by the almost entire absence of sardines (paragraph 5 supra) so that the experimental investigation of improvements devised to improve the oil and prevent rancidity could not be carried out. The good effect of ordinary caustic lime on the effluent water, in place of the expensive chloride of lime, was partly, but as yet insufficiently, demonstrated; this is an important result as the effluent water is apt to be a nuisance.

But the making of fish-oil soap was the main duty of the oil chemist. At Bangalore he got in touch with the Agricultural and Military authorities and at their request experimented in special soap making, using Tānūr fish-oil and stearine as the fatty constituents; the Agricultural authorities required the soap for insecticidal work; the Military demanded a good harness soap. Owing to the absence or great costliness of potash by reason of the war, the chemist was forced to use soda and succeeded in making a soap which was found highly insecticidal, both for bug and scale on coffee, for tea pests such as the bark louse, mildew, etc., and—very diluted—for mango hoppers; the solution also kills larger insects such as ants and grass-hoppers, but though thus inimical to insect and fungoid pests it is wholly innocuous to plant life. Experiments are also being tried on the fungoid pests of the areca nut, etc. Two soaps are made for planters' requirements, viz., a pure fish-oil soap, and a fish-oil rosin soap; the latter merely requires admixture with water to form a spraying solution, thus relieving planters of the trouble of dissolving their

rosin as is usual. Opinions differ as to the formulæ to be used, as some planters prefer alkaline soaps while the scientists desire it neutral: there is at present much to learn in the matter since soaps must probably differ considerably according to the insect to be destroyed, its stage of life, the time of year, the character of the crop (coffee, tea, etc.), the rapidity of action required, and even the elevation of the estate; the chemist has made a number of enquiries on various estates.

Up to date about 18 tons of soaps have been made and issued and a very useful profit obtained; the demands for next season are likely to be far greater, and with fish-oil and stearine cheaper we can give even better terms or take larger profit.

The military authorities have not yet reported on the soap supplied to them. Should this be equally successful there will be an excellent outlet for fish-oil and stearine on the coast.

44. Plant was locally obtained for making these soaps and is now available for considerable experimental work. Advantage was taken of the technological knowledge and skill of the chemist and of the results of analysis when examining the soaps generally used by planters and for harness and leather, to experiment in ordinary soaps, and the expert succeeded, even with small handstirred plant, in making high quality genuine soaps which have been tested with excellent results for some months. Sanction was given by Government in March 1915 for further experimental work.

From—Sir FREDERICK NICHOLSON, K.C.I.E., Honorary Director of Fisheries.
Dated—Madras, the 26th August 1916.

I have the honour to submit my annual report for 1915–16.

2. * * * * *

3. The staff remained the same as in the previous year, except that Mr. B. Sundara Raj, M.A., was appointed and joined as Assistant to the Piscicultural Expert on 23rd December 1915. Owing to unforeseen circumstances the Honorary Director continued in office during the year.

4. The following is a resumé of main operations in the various branches :—

Director's branch.—General control of the department; Tānūr fish-curing yard including curing, smoking, pickling (salt and vinegar), fish oil and guano, vinegar, glue, etc.

Cannery at Chāliyam (Beypore), with experiments in solar heating.

Soap-making at Tānūr.

Miscellaneous, including tuition, socio-economic work, the Madras Exhibition, Bulletin writing, etc.

Piscicultural Expert's branch (Mr. H. G. Wilson).—The Sunkesula fish farm, that at Ippur, larvicidal work, the stocking of tanks, the re-introduction of gourami, Nilgiri trout culture, the conservancy of various waters, the detailed examination of the waters of Coorg and South Kanara and of a variety of large tanks in the districts for conservancy purposes, Exhibition, project, and miscellaneous work.

The Marine Biologist's branch (Mr. James Hornell, F.L.S.).—The Tuticorin fish-farm, the edible oyster farm at Pulicat, the pearl oyster culture farm at Krūsadai (Pamban), the preparation of specimens for distribution and for educational work, béche-de-mer cultivation, Exhibition work, investigations for and writing of Bulletins, research, and miscellaneous.

Pearl and Chank branch (Mr. James Hornell, F.L.S.).—Chank work over the whole coast between Madras and Cape Comorin, including the great fisheries of the Tinnevelly and Rāmnād district; chank cutting experiments, Exhibition and miscellaneous work.

The above and other matters are dealt with seriatim and in detail below, the reports of the Piscicultural Expert and the Marine Biologist being printed almost in full, and an abstract given of pearl and chank fisheries operations which are separately reported on.

5. *Director's branch.*—This was run directly by the Honorary Director with the co-operation of the Assistant Director Mr. V. Govindan, B.A., and the Oil Chemist Mr. A. K. Menon, B.A. It includes the mass of work connoted by the expression "general supervision and control of the Fisheries Department" whether administrative, technical, or financial, and needs no special mention except that each year necessarily and rightly increases the volume, diversity, and complexity of the work. The negotiations for a new expert Director did not materialize and the present officer has had to carry on. It also includes the industrial sections worked at the Tānūr fish-curing and oil and guano yard, the Beypore cannery, and the soapery.

6. *Tānūr experimental station.*—The year was absolutely disastrous; a year of fish-famine, not merely at Tānūr but along the whole coast. The measure of this scarcity may be gauged by the fact that only twice, and in November only, were sardines procurable for oil and guano at Tānūr, while at the cannery sardines for canning were only obtained on five occasions from 1st November to the end of February while they should have been obtained ten or twenty times as often; consequently there was hardly any oil and guano or fish manure on the coast, and prices for the minute quantity obtainable were out of all proportion. Mackerel were almost equally scarce, and the early cat-fish shoals for which large profits are obtained, were very scanty. A further result was the comparative absence of the larger fish which feed on the smaller. Hence ordinary operations were scanty, and only prawns gave fair results. There is little to record because little could be done.

7. *Pickled mackerel.*—A new departure was made in picking mackerel, but these were too scarce for serious treatment. Those pickled with salt, like Scotch and English pickled herring, and sold moist, were favourably received, but the cost of mackerel this year, the expense of containers, the difficulty of getting water-tight

containers, the weight of moist fish, and the long railway journeys entailing heavy freight, make the success of the experiment doubtful ; it will however be thoroughly tried next season when mackerel may be cheaper and the experiments on a larger scale.

A further departure was made in pickling mackerel with vinegar and spices, the latter being either pepper only or a variety. The idea is (1) that vinegar, being a strong antiseptic, will therefore keep the fish in better condition than when merely salted and will also minimize the use of salt which is wasteful both of nutriment and flavour ; (2) that the product will be both palatable, and salutary as an internal antiseptic ; (3) that the product can be used by poor people as a condimentary addition to cereal foods rather than as a food in itself and thus provide a wholesome and savoury addition instead of that too often supplied by putridity or "high" condition ; (4) that being fairly proof against putrescibility, a keg or tin can be opened by a retailer and sold in very small quantities to petty consumers. The method is applicable to fish other than mackerel, but this fish is usually abundant and cheap, and a sort of pickled mackerel known as Colombo-cured mackerel is already made by Colombo curers on the coast and sent entirely to Ceylon ; this is a very hard-cured and unacceptable product.

The trouble is with containers since small kegs are dear and often not water-tight either because of unsuitable (porous) wood or bad coopering, while kerosine tins are acted upon by the vinegar ; this difficulty is being got over by employing a good cooper and by double lacquering the kerosine tins inside. The experiments will be continued next season as very promising if the expense can be recouped.

8. *Vinegar.*—An essential item in the above cure is cheap and good vinegar. British vinegar can never be very cheap, since it is an article very bulky for its value and has to be sent out in expensive casks ; dear at all times, it is, at present, of prohibitive cost. Local vinegar made from toddy is only moderately cheap (about 12 annas per gallon) but is so weak as to be almost useless. Consequently the manufacture of vinegar was begun late in the year ; the "quick process" was adopted, the *alcoholic* base being rectified spirit with various feeding

additions. The small generator was self-devised and made, and has made some 62 gallons of very pure aromatic vinegar at below the cost of local vinegar but of double the strength. Compared with British vinegar it is about the price of such vinegar delivered in Madras in normal times but should easily be made at half such price. Owing to inexperience, to the imperfections of the generator, but above all to the great heat of the climate and of the improvised vinegar room and consequent undue fermentation-heat in the generator, the process, so far, has been unduly wasteful, though successful in result and fairly successful in cost notwithstanding the abovementioned and many other difficulties, including the great cost of the rectified (though duty-free) spirit at Tānūr, the necessary wastage in petty operations by want of skill and practice, and the undue retail cost of the materials added to the *alcoholic* base. Perhaps the climate has been the worst trouble, for with 90° to 95° F. as atmospheric temperature there is little margin for the necessary fermentative increase of temperature, since the maximum permissible limit in the generator is 104° F. Consequently much alcohol was probably wasted as volatile aldehyde, while the acetic acid produced was possibly further decomposed after formation.

Experiments in this and in the slow process will be further conducted during the current year both at Tānūr and Coonoor, but the attention of Messrs. Parry & Co. has been invited to the matter, since every condition will be more favourable in a vinegar factory attached direct to a great distillery with weak spirit, plant, and skilled supervision abundantly available.

9. *Glue.*—An attempt was made to make fish-glue from various waste parts of the fish cured in the yard, but the quantities available were small—partly owing to the nature of the season—and sufficient attention could not be paid to the matter which was (partly) suggested by an application from a cotton mill for good fish-glue. This will be carefully considered during the current year.

Small consignments of shark skin—a by-product—have been supplied to the Police Department for sword handles, etc.

10. *Oil and guano.*—Only about $2\frac{1}{4}$ tons of fish guano and a proportionate amount of oil were made during the year owing to the unprecedented famine of sardines. A forward contract for 10 tons—subject to the capture of fish—had been made with a planter; early in February it was by consent attempted to make up this small amount by local purchases, but only half a ton was available on the whole coast from Tānūr to Mangalore and that was offered at double the normal rates. This incident demonstrates the character of the scarcity; the 250 private factories did hardly any work during the season. There were forward contracts made by parties on the coast for 400 and 500 tons which were absolutely unfilled.

New and simple plant intended to promote the manufacture of the best oil at the lowest cost and in the simplest manner is in hand.

11. *Cannery.*—The same scarcity of fish entirely spoilt canning operations at Beypore; sardines were only obtained five times in four months and mackerel were but moderately available. Hence the number of tins packed was very small, especially of sardines. The applications received and declined for want of stock number hundreds.

For lack of the true oil-sardine *(Clupea Longiceps* or "nalla matti") the châla matti *(Clupea fimbriata)* was tried, but proved to be fit only for third-class work, being lean, tasteless, and very bony.

The new plant for making solderless tins was successfully brought into operation, but had only scanty scope for its considerable capacity.

12. Fish frozen after the Henderson method was very successfully prepared and experimentally distributed. A small refrigerating plant and oil-engine had been set up, in which the fish, previously cleaned and slowly cooled to about 35° F. to get rid of the animal heat, was plunged into clean brine at a temperature of from 10° to 15° F. The frozen fish when removed were packed in paper and a basket with 2 or 3 inches of paddy husk as insulation, and in this way travelled successfully for several hundred miles and up to two days in time on many occasions, without a single failure, even though, as personally seen, the parcels were

unnecessarily exposed to the midday sun on an open railway platform. Experimentally the process was quite successful: commercially two things are requisite, viz., (1) an organized and continuous supply of really fresh fish of a quality worth the cost of refrigeration and railway parcel carriage, (2) a plant sufficiently large to deal with several hundredweight at a time, since the expense of engine power and expert attendance cannot be recouped on small quantities, and the railways can hardly provide the special accommodation which would still further assist the process, without considerable and regular consignments. Point (1) will be further dealt with during the current year as two Ratnagiri boats have been bought for deep-sea work ; it may then be possible to bring in a fair amount of good fish in good condition, and the plant can deal with about one hundredweight at a charge.

13. The abovementioned boats were bought too late for work during the year, but will, it is hoped, give considerable data and useful quantities of fish during the current year. They were bought very cheaply and are provided with nets ; our own crews are able to work them, and this will to some extent solve the difficulty of getting deep-sea work done now that Ratnagiri boats find plenty of work on their own Bombay coasts and have ceased coming south.

14. The necessity for protecting the inside of tins from the action of vinegar and of prawn flesh, etc., led to various experiments ; up to date, double lacquering, well stoved to obtain a hard texture and to bind it to the surface of the tin, has been found fairly successful. This double stoving was troublesome and somewhat costly in fuel (kerosene); hence a return was made to old Cannanore experiments in sun heating in a "solar oven." This is simply a stout teakwood box, blackened inside, provided with a closely fitting, double glass top and insulated by insertion in an outer case with double walls ; the tins are filled into this and covered with a blackened tin sheet ; the double glass top being placed in position, the direct rays of the sun readily traverse the glass which, however, intercepts the radiated heat. With this simple apparatus a midday (11 A.M. to 3 P.M.) temperature of from 240° to 275° F. has been readily attained,

and 290°.* F with the aid of a single glass mirror. The stoving is excellently done, the heat cannot rise too high (300° F. is the maximum permissible for soldered tins), and costs absolutely nothing. For all mere oven or baking (or cooking) purposes this is a very efficient and cheap application of sun heat available in many occupations and industries; it is useless for evaporation but will be used, with the necessary adaptations now being devised, for supplying hot water at boiling point and perhaps low pressure steam; this will be most useful in various cannery, oil and guano, and soap-making operations. With mirrors far greater heat can of course be obtained. The subject is being pursued as giving an almost costless source of baking or stoving heat, but the West Coast is the wrong locality for experiment owing to a long south-west monsoon, frequent cloud, and a moist atmosphere which muffles or absorbs and, to that extent, lowers direct heat.

15. *Cannery shortage.*—The abovementioned shortage of fish has been a main factor in the production of complaints against the cannery for deficiency of goods; complaints which are as complimentary as unreasonable. For canning purposes sardines and mackerel are the permanent mainstays of Indian work and when these fish are absent the largest, best managed factory must run short of goods unless it is old enough to have accumulated great reserves. Usually sardine and mackerel in condition for canning (all sardines are not) are frequent from September to April; during the season under report, viz., 210 days from 1st September, sardines were obtainable only on 15 occasions, of which there were only 5 from 1st November to 31st March, usually the height of the canning season; mackerel on 44 occasions of which only 13 were in 1916. Hence, since the cannery though well fitted, is small and is still young and experimental, only a few thousand tins could be prepared. In fact the previous year was also bad, so that July 1915 found the cannery practically without stock; this reacted unfavourably in the year under report since masses of

* With tin-plate reflectors attached to the sides and an arrangement for keeping the glass cover of the oven perpendicular to the sun's rays, 310° F. has easily been attained (March 1917) and the period of high temperature greatly lengthened.

early orders came in from September 1915 which could not be filled and cans had to be sent out as soon as they had passed the observation stage.

Only experts know, moreover, how much fish has to be rejected as tainted or soft from long detention in the boats and how short a time—a few hours—is available from the arrival on shore, even of fresh fish, before the fish in these tropical regions are useless for canning. Only when catching is organized as completely as canning (i.e., when the habits and methods of the fishing classes and their subservience to local capitalists are radically altered) will it be possible fully to utilise any cannery, and even such organization would be useless in seasons such as 1915–16 when fish are totally absent not merely from the neighbourhood but from the coast in general. The negotiations for a motor launch which is a necessity even in ordinary years for the main reason given above, viz., the necessity for frequent supplies of absolutely fresh fish, have unfortunately fallen through, but a cannery launch will be necessary in 1917 for this and other purposes.

Moreover the demand is itself largely responsible for the absence of stock ; hundreds of orders were received at the beginning of the season when, as mentioned above, there was no stock in hand, and so many orders are habitually received, literally from Kashmir to Ceylon, that it has been necessary to refuse all except Presidency orders. The public have learnt even in three years, mainly of experiment, that our cannery goods are both cheap and good and that it is highly profitable to deal direct with the factory and not with a middleman or retailer. A commercial cannery is constituted to turn out cans by the million and not by the ten thousand ; moreover factories when old-established and not new, usually keep an enormous reserve, partly to allow of goods maturing, partly as the surplus of abundant years ; hence some of the difficulties of a small and new factory which moreover is primarily constituted to make goods as experimental and demonstrational essays, and sells them partly to get rid of them, partly to advertise the facts and cost of canned goods in view to the development by others of commercial work. But for the war it is almost certain that one and possibly two firms from

England would have taken up the matter on data supplied by the department, and in fact a Madras European firm has now bought up the Mahé cannery and intends, partly with the aid of our experiments and experience, to develop a commercial business.

It is also to be remembered that dealing direct with a single factory is wholly different from dealing with a store or shop which draws its supplies from perhaps dozens of factories in many countries so that the abundance of one compensates for the deficiencies of another ; even so a shop is often " out of stock " but it is not usually blamed for such deficiency.

16. *Deep-sea work.*—This has never yet been attempted by the department which has confined itself in its early life, to the work lying more nearly to hand, such as curing, fish-farming, etc. ; it was considered better with very limited staff, funds, and experience, to examine existing methods, to attempt to improve as food the fish caught by such methods, to learn the conditions affecting inshore catching and curing, and to apply our energies to local improvements, *before* launching out literally into the deep. Deep-sea work demands material and superintendence which we have not got and which are very costly, and though a beginning was attempted in the sanctioned recruitment in 1913–14 of a master fisherman and his mate, the matter fell through—though the men had actually been selected in July 1914—by reason of the outbreak of war ; the men selected are now mine sweeping. The work will be a prominent feature of the next decade.

17. The boats built some years ago (" Turbinella " and " Sutherland ") though good in themselves were unsuited to fishery work in these waters and to the handling of Indian crews, while they are not big enough —nor have we the men—to accommodate British master fishermen in long deep-sea voyages. For a couple of years the Ratnagiri deep-sea boats which came after the monsoon to South Kanara and Malabar coasts, were utilised, but these have now ceased coming south owing to improved fishery conditions in Bombay and they refuse to be hired on any reasonable terms. These boats with their native crews can stay far out at sea for some days together, and it is therefore quite possible to

begin deep-sea work with their aid, though it is barely possible to get fishing data intelligently logged by the skippers, or the fish sufficiently well treated on board. Hence with Government sanction two boats with nets, etc., were bought by the Assistant Director, too late for use during the past season but now ready for immediate work when it is hoped with our own trained crews, (1) to explore to some extent the deeper waters up to the 100 fathom limit, (2) to obtain a supply of the larger sorts of fish for the cannery and curing yard, (3) to pay special attention to the whereabouts of shoal fish (sardines, mackerel, etc.) when not found inshore, (4) to experiment in the better treatment, temporary preservation, etc., of fish on board, (5) to engage in other miscellaneous duties such as those of carriers.

18. *Work of the Piscicultural Expert* (*Mr. H. C. Wilson*).—This was, as usual, entirely on the fresh waters of the Presidency; the chief items are catalogued in paragraph 4 supra, and the details will be found in Appendix I which contains the bulk of a report written for this annual report. A further summary would be useless ; moreover where, as in this and in Mr. Hornell's report, there is so much of interest, even in the details, it appears useful to publish the whole of the two reports rather than a summary, it being, however, understood that where there may be debatable matter rather than facts, the opinions or expectations expressed are not necessarily accepted by the Director. It may be mentioned (though the result belongs to the current year) that the considerable consignments of gourami (*Osphromenus olfax*) both from Mauritius and from Java (see paragraph 9 of Mr. Wilson's report), were most successfully transported to Madras and both batches are doing well ; this introduction should be highly useful in the course of a few years. The Mauritius consignment was prepared and despatched entirely by the care and courtesy of the Government of Mauritius to whom our cordial thanks are due and have been sent. The other batch was personally collected and conducted by Mr. Wilson who went to Java—where the fish are indigenous—for the purpose, and by the kind assistance of the authorities

in Java and of the several shipping companies, was able to bring the fish to Madras with very moderate loss.

19. *Work of the Superintendent of Pearl and Chank Fisheries and Marine Biologist, Mr. James Hornell, F.L.S.*—A list of work supervised and done by Mr. Hornell is mentioned in paragraph 4 supra, and all details are mentioned in his report, written for this annual report and for the most part printed as Appendix II. Where so much is of interest it is difficult to select, but attention may be specially directed to Mr. Hornell's success in dealing with the chank diving population especially in the newly leased fisheries of the Rāmnād district, and in the initial and successful attempt to relieve the divers from undue thraldom to merchants, money-lenders, and boatowners. Incidentally the success of his measures led to unprecedented success in winning chanks, so that the net profit —all expenses deducted—from the several chank fisheries amounted to Rs. 51,000 for the year (ending 30th June), a revenue not hitherto approached. It may here be noted that, given similar and increased success in subsequent years, this department may, in a few years, become wholly self-supporting, considering (*a*) the above and increasing net income, and the possibilities from culture pearls and fish-farms, (*b*) the increased rentals obtained for the rivers and tanks under Mr. Wilson's conservancy operations, and from his fish-farms, (*c*) the returns from the Government fish-curing yard at Tānūr with its sales of cured fish, its oil and guano operations, its vinegar and other miscellaneous sales including the produce of over 500 cocoanut trees planted by this department, (*d*) the sales of the cannery, and (*e*) of the soapery which, at least on the side of its fish-oil soaps, is attached to this department.

20. *Work of the Assistant Director.*—This has consisted partly in assisting the Honorary Director in running the West Coast stations, partly in supervising all office work including the disposal of routine matters, and the examination of accounts, vouchers, etc., partly in tours of enquiry for general purposes and for the preparation of Bulletin No. 9 which is mainly his work, partly in that socio-economic work (see paragraph 21 infra) in which

he is deeply interested and for which his knowledge and experience are invaluable. He was also mainly instrumental in preparing the West Coast fishery exhibits for the Madras Exhibition, and was also a member of the Central Committee.

21. *Social work.*—As will be seen from Mr. Hornell's report, good work has been done by him in connection with the chank divers in the way of assisting them to escape from the thraldom of dependence on boatowners and other capitalists petty or otherwise ; he has also further plans for assisting the ordinary fishermen to obtain boats and gear by Government loans, and this will be seriously taken up in the current year. On the West Coast Mr. V. Govindan, Assistant Director, has especially interested himself in similar matters, but more from the co-operative and association standpoint, feeling that the fisherfolk over great areas are "not in touch with the civilised world" and that they require awakening and stimulating. Ignorance, superstition, and hidebound routine are but one item of backwardness ; poverty and economic thraldom to the money-lender, whether merchant, curer, or boatowner, form another ; intemperance and entire unthrift a third ; while the uncertainty of mere inshore fishing, the inability to fish the deep, the long idle period—especially on the West Coast—of the monsoon, the numerous holidays and off-days, and the sickness induced by insanitation, are a fourth. Bulletin No. 9 published during the year and mainly compiled by the Assistant Director gives a good deal of first-hand information on the condition of the fisherfolk, but this is only a basis for much closer enquiry during the next few years.

22. It will be seen, then, that on this socio-economic side enormous problems lie before the Fisheries Department if it is to do its full duty by the fisherfolk. Something is being attempted, and, best of all symptoms, partly by the people themselves. This department has, through the Assistant Director, established a co-operative society at Tānūr, and a second was formed and registered at Tellicherry with above 100 members, of whom about 30 were female curers and fish hawkers ; another was in process of formation at Quilandy. The Tānūr society was greatly hampered by the fish famine which, in fact,

necessitated considerable private charity. The temperance society at Malpe, mentioned in previous reports, is developing into a co-operative society by the terms of its formation ; during the two years of its active life its 70 members, chiefly young men, have, as per their rules, accumulated a fund of Rs. 700 which represent their savings by abstention from drink, in itself a very notable fact. This fund is to be utilised in loans to the members ; hence the development towards co-operation while maintaining the original object.

23. The Tānūr evening school continued to work at elementary education and appropriate industrial operations ; additions are to be made shortly to its attractiveness, and in South Kanara some of the fisherfolk are anxious to have a similar night school. But the Assistant Director reports that in places, especially on the East Coast where the fishing hamlets are overgrown with prickly-pear and consequently very insanitary, the folk would rather have the hamlet swept and garnished and sanitated than provided with a school, and it is undeniable that filthy surroundings and bad water have much to do with intemperance and disease. A combination of Government loans for the purchase of boats and nets, of co-operative societies for the general uplift of the people in the wonderful co-operative way, and of schools for instruction in general knowledge, in accounts, in special nature-knowledge, and in the industries by which they live, will be the potent instruments which this department will now have to use, under new auspices, for the development not so much of fisheries as of the fisherfolk.

24. *Soap works.*—This, as before, was under Mr. A. K. Menon, B.A., an officer trained in England both in the work of an oil chemist and in that of practical soap manufacture. This series of operations is dealt with under "Fisheries" though distinct therefrom (1) because it originally (1913) sprang from Fisheries, (2) because the soapery has, for reasons of convenience, been hitherto placed by Government under the Director of Fisheries. There are two sides to the soapery which it is well to define carefully, since the public is apt to suppose that the *ordinary* soaps, now about to be put on the market, are made from or with fish oil which, of course,

is absolutely incorrect and is an idea merely based on the fact that the operations are in charge of this department. The first side is that where fish-oil and stearine are worked up into *insecticidal* soaps for use by planters, fruit growers, etc. ; this is a derivative industry from the production of fish-oil by the department. The second side deals with the production of *ordinary* soaps for household and personal use, in which fish-oil finds no place whatever, its sole connection with fisheries being in its direction, and, till now, its location at Tānūr.

25. During the year fish-oil insecticidal soaps were made to the amount of about 28 tons (including balance) and nearly 25 tons were sold. Of these the greater proportion was a soap containing rosin which the planters prefer to plain soap ; as stated last year, this rosin soap readily dissolves in water, so that an emulsion is formed by simply stirring a small quantity of the pasty substance in a pail or barrel of water. The plain soap continued to be sold with profit at Rs. 12 and the rosin soap at Rs. 16 per hundredweight, notwithstanding the rise in prices of fish-oil, alkali, and rosin.

A larger demand was anticipated, but the year proved less pestiferous than usual ; moreover it was reported from some estates that areas treated last year with this soap were less infested than before. The soaps were very favourably reported on by the Government Entomologist as against "mango hopper," a 75 per cent crop being considered probable where such means are adopted ; if this is so, there should be a wider future for these insecticidal soaps. Enquiries were received about this soap from the Punjab to the Federated Malay States.

26. The soapery for ordinary soaps is, however, far more important, and its small scale operations very sucessful. With a small 1-ton locally made pan and some frames, excellent soap has been made of various classes, samples of which were exhibited at the Madras Exhibition ; subsequently sales have been frequent—about 3 tons—though, owing to the smallness of operations, to the work on the fish-oil soaps, and to the heavy work of opening a new factory on a larger scale, the soap has not yet been placed in bulk on the open market but will be by the time that this report is issued.

The cost has been most carefully calculated and the registers, drawn up on regular factory lines, will show the precise cost and profits not only of each class but of each batch of soap so that reliable data will be available. The prices have recently been settled and though glycerine has not yet been recovered, the proposed prices give reasonable profit as will be demonstrated in the next report.

27. Owing to the demonstrated success of the soaps, Government were pleased, towards the end of the financial year, to allot Rs. 75,000 for soap experiments during 1916–17, and special instruction was given that operations should include glycerine recovery. Orders and offers were consequently sent to England to one of the chief makers of soap machinery, and a toilet soap plant and other machines were fortunately obtained from stock and are now (August) on their way out. The larger and less complicated plant has been made out here, but, owing to the war, there has been grievous delay and extra cost in obtaining the plant which includes a 5-ton soap pan, boiler, etc., all now in place; it is difficult at present to obtain even common iron tanks. The vacuum glycerine plant will probably not be available for many months, but an ordinary evaporation plant is being erected, to be steamed from our new boiler. The new plant at Calicut should be making soap by 1st September and the toilet soap plant may be in operation by 1st October.*

28. The soap made is solely genuine soap without any adulteration or even filling; it has excellent lathering qualities, and can be sold at a good profit more cheaply than Western soaps of equal character. As mentioned in a lecture on "Soap" at the Madras Exhibition, oils are available out here at cheap rates which are unknown—in practice at all events—to the Western soap maker; e.g., Mr. Menon re-discovered an oil which, prior to the entry of kerosine oil, was a general illuminant on the West Coast, but has now largely fallen into disfavour and is proportionately cheap; this is an excellent soap oil and will be largely used. Other oils and fats than those commonly known are and will be tried. Owing

* Owing to unavoidable delays work did not fairly begin till January.

partly to the high price or total absence of synthetic perfumes and colours but mainly to a desire to use indigenous products only, experiments have been made in using these latter, and quasi-toilet (cold process) soaps of a very pleasing character have been made with very low charges for perfume.

It may be mentioned that samples of our soap sent home were reported to be "too good for the price"; it will be gratifying if both quality and price suit both consumer and manufacturer.

29. Mr. Menon made several tours and accumulated considerable information not only as regards the sources and prices of raw materials of all kinds, including indigenous perfumes, but of the Western soaps most in favour in this Presidency. He also prepared a capital exhibit for the Madras Industrial Exhibition which, however, would have been more useful if it could *atonce* have been followed up by commercial operations. He also attended the United Planters' Association where he read a paper on "The Uses of Soap as an Insecticide," and discussed the question with the assembled planters.

Altogether the work done, considering the delays caused by the war and the necessary difficulties attending the start of a new industry, was satisfactory

30. Notable features in fisheries industrial work were the display of products, from all branches of the department, at the Madras Exhibition, and the visit of a Member of Council (the Hon'ble Sir Alexander Cardew) to the West Coast in October 1915. Both events proved to be of importance and assistance, and Sir Alexander's visit gave very desirable encouragement to those supervising this set of infant industries.

31. A great British firm consulted this department regarding the opening of oil and guano works on the Departmental system and this, it is believed, is in process of initiation; also as regards the preparation and use of certain oils in another direction.

32. Owing to the extraordinarily bad season little work was done during the year by the 244 small private oil and guano factories which have been established, more or less on this department's system.

33. *Miscellaneous.*—The usual amount of correspondence was carried on with other departments, with

purveyors of material and plant and consumers of goods, with enquirers, etc., many miscellaneous experiments were conducted, both successful and the reverse. The Madras Industrial Exhibition gave considerable work to the department but the results were worth the trouble. The following Bulletins were published during the year, viz. :—

(1) Bulletin No. 1 consisting of papers from 1899 relating chiefly to the development of the Madras Fisheries Bureau ;

(2) No. 8 dealing with marine fishery investigations in Madras, 1914–15 ;

(3) No. 9 being a first attempt to display with some degree of accuracy certain statistics relating to the fishing population of the Madras Presidency.

34. As required by Government the receipts of the department and the expenditure relating to certain of the items are shown in an Appendix (III).

APPENDIX I.

Report by H. C. Wilson, Esq., Piscicultural Expert, Madras Fisheries.

I was in charge of the piscicultural operations during the year under report as Piscicultural Expert and was engaged in tours of inspection and special investigations. Most of my time was therefore spent in touring and the following districts were visited during the year :—

South Kanara was visited twice in April and January to examine its rivers, as instructed in G.O. Mis. No. 1543, Revenue, dated 28th May 1914.

The Nilgiris were visited in connection with the hatchery work, stocking of streams, etc., in the months of May, June and November.

I toured in the Kurnool district in the months of July, February and March in connection with the Sunkesula fish farm, stocking of the Kurnool-Cuddapah canal, examination of permanent water-tanks, inspection of the Kistna Gorge, investigation of the Nallamalais to draw up an anti-malarial scheme, etc.

September, October, and March were spent in visiting Hyderabad, Vizagapatam, and the permanent waters near Madras and in the districts of Chingleput, North Arcot, etc.

Coorg rivers were again inspected agreeably to the orders of Government to decide the suitability for re-stocking with non-indigenous fish and suggest for the improvement of their fisheries.

2. *Staff.*—The several posts sanctioned for my branch during the re-organization of the Fishery Department were all filled up during the year.

Mr. B. Sundara Raj, M.A., who was the Zoological Assistant in the Madras Museum, was appointed as my Assistant in December last. He was specially deputed to investigate the more or less permanent waters of the Presidency and report on their suitability or otherwise for the improvement of their fisheries. Most of the important tanks in the Presidency excepting those in the districts of Cuddapah and Northern Circars were inspected and reported on. He has also made a preliminary investigation of the fisheries of the several branches of the Gōdāvari river from the anicut to the sea, in connection with our scheme for conservancy and re-stocking of the upper waters of the Gōdāvari and its perennial tributaries, Sileru, Sabari and Machkand rivers, which I hope to complete this year. Several tanks have been selected and steps are being taken to improve their fisheries, by introducing valuable non-indigenous species of fish.

*   *   *   *   *

3. *Sunkesula fish farm* . . . The farm work progressed well during the year. A large head of quick growing non-predaceous carp were maintained at the farm for stocking purposes and these were mostly turned out into the Tangadencha tank with a view to counteract the deleterious effect due to the breaching of the tank the year before last. To give the introduced fish a good chance of breeding, the fishery of this section of the canal will not be auctioned for a few years, until the tank has again become fully stocked by our operations. Many thousands of murrel fry bred at the Sunkesula fish farm were turned out into the Edurur swamp for growing.

One of the breeding ponds was set aside and specially prepared for the breeding of Osphromenus olfax. The acclimatisation of Tench (Tinca vulgaris) bids fair to be a success, but of course takes considerable time.

4. *Hilsa hatchery.*—I am sorry to say that there were no operations at the hatchery owing to the absence of ripe fish. I deputed my Sub-Assistant to wait at the Lower Anicut during the most likely time for obtaining ripe fish, but to no purpose. I have found it is only in exceptional years that those fish can be obtained in this condition.

5. *Stocking of tanks and canals.*—As mentioned in paragraph 3 supra most of the fish from the farm were turned out at Tangadencha tank, which is a natural distributing centre for the whole of the Kurnool-Cuddapah canal. The following tanks were also stocked :—

Daroji tank	Bellary district.
Kamalapuram tank	Bellary district.
Markapur tank	Kurnool district.
Venkatapuram tank	Kurnool district.
Belegal tank	Kurnool district.
Badai Khan tank	Kurnool district.

The tanks of Barur and Penukondapuram, Salem district, were stocked with E. Suratensis a species which is non-indigenous to these tanks.

6. *Collair scheme.*—This work is at present being held up owing to the existence of stake nets and basket cruives, the removal of which is absolutely necessary for working out the scheme successfully and it will be taken up later.

7. *Ippur fish farm.*—This is still under construction and from the recent report I had from the Executive Engineer, Nellore, the farm will not be ready for another three months. All the heavy fishery utensils were, however, removed to the farm and kept in the store room and some of the ponds have also been planted with lilies. The farm will, it is hoped, be brought into working order before the close of the current financial year.

8. *Acclimatisation of tinca vulgaris.*—As stated in paragraph 3 supra, the small consignment of these fish which was introduced into the Sunkesula fish farm in February 1914, was again supplemented by a further consignment during the year under report. The result will be reported in due course.

9. *Powder factory scheme.*--The ponds in the late gunpowder factory at Vyasarpady were handed over to this department on application from us, to utilize them for piscicultural purposes. My scheme to use these most valuable ponds for growing larvicides and other valuable fish was sanctioned by Government in G.O. Mis. No. 1854, Revenue, dated 9th August 1915. The several ponds were cleaned and provided with suitable shutters, screens, etc., and stocked with the following fish, viz., Etroptus suratensis, Megalops cyprinoides and a large number of larvicidal fish. E. Suratensis are being kept specially for introducing into many of the permanent water tanks —vide my letter Ref. No. 167, dated 16th June 1916, where they are at present non-indigenous. These fish which are highly prized by the Indian population, will be bred on a large scale at our farms for stocking districts where they are at present non-indigenous.

One of the ponds is set aside for O. olfax (gourami) as a resting place (after their long journey) for the consignments which we hope to get (since obtained) from Java and Mauritius. These will be distributed to the fish farms where careful selections will be made for breeding purposes. The flesh value of these fish is exceedingly great and they should eventually prove a most valuable addition to the food supply of the country. They are non-predaceous and live mostly on pond weed and lilies.

10. *Nallamalais scheme.*—As per my report,; dated the 15th September 1915, approved by the Surgeon-General and sanctioned by Government in their Order No. 2689, Revenue, dated 3rd December 1915, this scheme is to try and improve the notorious fever zone in the Nallamalais, Kurnool district, by the use of fish larvicides. Arrangements are being made for breeding these fish in large numbers in the hills at a site chosen as near as possible to the scene of operations, for the purpose of stocking all the isolated permanent water-holes existing in these jungles. During the dry weather the above mentioned holes form the only possible mosquito-breeding and

collecting places over an exceedingly large malarial infected area. Owing to the dryness of the atmosphere in this district and during this period, mosquitoes can only exist in close proximity to moisture; otherwise, from observations made, I have noticed that their bodies soon become shrivelled and the mosquito dies. It is also highly probable that long before all moisture has left the bodies, their network of breathing tubes (tracheae) become dry and useless and the mosquito suffocates; at all events, it will not survive long in a dry climate without moisture.

It is natural when the dry weather sets in, for mosquitoes to collect at these permanent water-holes, and here large numbers of anophelenes can be found where they breed and their offspring are enabled to survive the dry period by remaining near the water. During this trying period all animal life concentrates round these water-holes, and the necessary blood without which the female mosquito cannot deposit fertile eggs, is always obtainable. The quiet undisturbed surfaces of these water-holes heavily charged with vegetable matter, form ideal breeding places for mosquitoes.

A large percentage of the Chenchus (the jungle tribe inhabiting these hills) are heavily infected with malaria, judging from the number of enlarged spleens noticeable, and as their camps at this period are of necessity in close proximity to permanent waters, it is not necessary to look further afield to find the source where the mosquitoes (the survivors of this dry period) become infected each year. This scheme is to attack all these permanent breeding ponds by the introduction of larvicidal fish. The site for the operations has been selected and the work will presently be put in hand.

11. *Red Hills tank scheme.*--During the year under report, a scheme was drawn up for utilising the permanent waters of Red Hills and Cholavaram tanks near Madras for the eventual distribution of valuable fish to other parts of the Presidency. The method of operations consists of constructing ponds for breeding and conditioning valuable non-indigenous fish where there is permanent water for stocking the tanks over a number of years. Dealing with these extensive permanent water areas which form the drinking supply reservoirs of Madras is slightly complicated owing to the prohibitions necessary to prevent pollution. This scheme avoids all danger from this point of view which is explained as follows :—

The site for breeding and conditioning operations has been selected remote from the Red Hills tank (the main drinking supply reservoir) near Cholavaram tank. As netting operations in Red Hills are objectionable from a possible pollution and health point of view, it is necessary to devise other means of procuring the resultant fry of these stocking operations or, in other words, of winning the harvest for further distribution throughout the Presidency. To enable us to carry this out successfully, we have of necessity to continue the stocking operations over several years with valuable non-predaceous species of fish, i.e., to overcome quickly all natural loss (from predaceous fish, etc.) and thoroughly establish the non-indigenous stock. It is the nature of these fish to breed in the reedy places of tanks and for their progeny after a certain growth to migrate up-stream

and they will in time naturally spread themselves throughout the entire system of Red Hills supply which includes an exceedingly large number of tanks and streams.

As soon as this takes place there will be a constant supply of fry running up-stream, i.e., up the supplying or feed channels, each year during the freshes and it is this supply we mean to tap in the main channel at Cholavaram and all other feeders, so that no netting need take place in the main reservoir of Red Hills.

That they will be established is an absolute certainty, as out of one large stocking alone there will be many survivors ; but to facilitate this, where we are dealing with such an enormous water area and to enable us to obtain a large supply in a quicker time, it becomes necessary to re-stock successively for a number of years.

The scheme was sanctioned by Government in G.O. Mis. No. 1126, Revenue, dated 18th May 1916, and the work will be put under way at an early date.

12. *Inspection of Coorg and South Kanara rivers.*—The above rivers were again inspected during the year agreeably to the orders contained in G.O. Mis. No. 1543, Revenue, dated 28th May 1914, and G.O. Mis. No. 2586, Revenue, dated 22nd November 1915. The Coorg rivers were inspected to ascertain the water temperatures and natural feeding, etc., so as to determine the most valuable non-indigenous fish to introduce. A final report was drawn up and submitted with my letter Ref. No. 87, dated 31st March 1916, embodying therein proposals for the improvement of the fisheries.

Some of the South Kanara rivers which had yet to be examined, were investigated during the year, and a detailed proposal is now being drawn up to improve the rivers pisciculturally by the establishment of a fish farm at Neriya in the Beltangadi taluk of the South Kanara district.

To put an end to some of the destructive methods of fishing, such as fixing stake nets, basket traps, etc., all the important rivers of the district were brought under section 6 of the Fishery Act for a period of two years from July last. This will enable the district officials to remove the fixed engines and prosecute the offenders, a necessary preliminary start for our future work of stocking.

13. *Fishery legislation.*—A small step was taken during the year in the way of fishery legislation. Fishery Act IV of 1897 is powerless for punishing poachers, because the removal of fish from public waters does not, under the existing law, constitute theft. This state of affairs gave immense opportunity for outsiders to fish with impunity even in the tanks and canals which were stocked by Government. On a strong representation, Government were pleased to bring all the tanks and canals that are operated on by this department under section 6 of the above Act for a period of two years. So also in the case of rivers, it was found absolutely necessary to remove or prohibit all destructive methods of fishing, such as basket traps, stake nets, poisoning, etc., by which means the rivers have for many years been denuded of fish including the merest fry. All the important rivers of the Presidency together with their tributaries were also brought under the above section of the Act temporarily for a period of two years.

14. *Inspection of tanks.*—Through the kindness of the Departmen of Public Works a list of tanks in the Presidency containing more or less permanent water was drawn up for inspection. As stated in paragraph 2 supra, my Assistant inspected and reported on all the tanks in the districts of South Arcot, Tinnevelly, North Arcot, Chittoor, Nellore, and Anantapur, while I inspected the tanks in the districts of Kurnool, Chingleput and the tanks near Madras. A proposal for dealing with these tanks has lately been drawn up and submitted in my letter Ref. No. 167, dated 16th June 1916

The fisheries of the following tanks were also taken up, viz., Belegal and Badaikhan, Venkatapuram and Kocheruvu tanks in the Kurnool district; in the case of the first two tanks the District Board concerned had to be paid compensation, while the fisheries of the latter two were assumed by us under G.O. No. 100 I., dated 20th February 1914. A proposal to take over the fisheries of the Kamalapuram tank in the Bellary district was submitted with my letter No. 794, dated 14th December 1915, and no orders have as yet been received.

15. *The Cauvery and Coleroon fisheries.*—The above fisheries which were taken up by Government were auctioned out last year in the districts of South Arcot, Tanjore and Trichinopoly. As stated elsewhere, these auctions were invariably attended by my Sub-Assistant to assist or advise in the matter. There is every tendency for the rentals to increase annually, due to the increased fishery harvest and consequent gain to the contractor. The conservation of the upper waters of the Cauvery at Hoginkal and that of the Bhavāni and Moyār have undoubtedly improved these fisheries considerably. Proposals were also submitted for taking over the Cauvery fisheries in the district of Coimbatore, but no orders have as yet been received on the matter.

16. *The Nilgiris fisheries.*—The conservancy of the Bhavāni and Moyār rivers is still being carried out in a satisfactory way; the upper waters of these rivers having a marked increase of fish and the fisheries of lower reaches far below these operations, are being vastly improved. The streams on the plateau are fully stocked with trout which are breeding so rapidly that re-stocking with live fish food has been increased. The fish have become so prolific that I will advise the removal of all restriction regarding minimum size to be retained by anglers and increase the limit of the number that can be killed under a single license during next season. My Inspector, Lakshmana Ayyar, has carried out his work in a satisfactory way.

At the request of the Chairman, Municipal Council, Cannanore, I visited Cannanore and its surroundings and advised him as to the best anti-malarial methods to adopt; see my letter No. 68, dated 29th February 1916.

The Chairman, Municipal Council, Bellary, was supplied with 2,000 mosquito larvicides for stocking purposes.

The Director of Industries, Banganapalli State, was also advised about the best method of stocking the wells and tanks in the State, and he is also being supplied with a small consignment of murrel fry for growing purposes.

As a result of the Exhibition held in December last, many enquiries were made about the use of the fish tin carriers, etc., and some of the enquirers were supplied with carriers and instructed how to use them.

The President, Taluk Board, Mannargudi, requested this department to inspect one of the tanks in the Mannargudi town and suggest the best means of improving its fishery. The tank was inspected by my Sub-Assistant and the President was advised about the methods to be adopted for the same.

17. *Remarks.*—All the more important waters of the Presidency are gradually being taken over by this department and are temporarily being stocked with the best kinds of fish indigenous to India. Later when large stocks are available at the different fish farms, I hope to introduce to all these waters non-indigenous fish, such as ' Osphromenus olfax and Tinca vulgaris, which will be of very much greater value as a food supply to the people and also to the fish revenues of the Presidency.

APPENDIX II.

Report by J. Hornell, Esq., F.L.S., Government Marine Biologist and Superintendent of Pearl and Chank Fisheries, Tuticorin.

I have the honour to submit the following summary of work done in my section of the Fisheries Department during the financial year 1915–16.

2. The operations under review may be grouped in five separate categories, namely (*a*) those dealing with the exploitation of the Government monopolies of the pearl and chank fisheries, (*b*) those concerned directly with the commercial development of marine industries, (*c*) those having for their object the economic improvement of the fishing population, (*d*) educational work, comprising fishery propaganda, the training of fishery students, and the provision of teaching collections for schools and colleges ; and lastly (*e*) the all important investigation of the life histories of food fishes and their enemies, together with those physical and biological problems which affect their abundance or their scarcity, and which in consequence control the prosperity of our fisheries.

3. *Financial results.*—I am pleased to be able to state that the working of this section has been phenomenally successful from the revenue standpoint, more particularly in respect of the chank fisheries. A far higher total of shells has been fished than in any previous similar period and as expenses have been normal, the result is that this section of fisheries will have a net profit to pass to the credit of revenue much higher than in any year since Government undertook the departmental conduct of this fishery. As the chank fishing year does not terminate till 30th June I am unable to give the exact figures of gross value of the produce and net profits thereon ; the former will, however, certainly exceed Rs. 92,000, and the latter Rs. 49,000, as against Rs. 40,014 and Rs. 16,759, respectively, obtained during the

year ending 30th June 1915. The net profit of over Rs. 49,000 constitutes a remarkable record, for the nearest figures are those for 1881–82, when Rs. 28,690 was obtained from the Tinnevelly and Tanjore fisheries. The pearl fishery contributed in addition a net sum of Rs. 2,000 as rental for the Tondi beds for the period from 1st June 1915 till 31st December 1916, while the following minor sources produced the sums noted against each :—

	RS.
Experimental fish farm, sale-proceeds ...	414
Oyster farm, Pulicat, sale-proceeds	315
Museum specimens and school collections, sale-proceeds	360
Miscellaneous items of revenue (net) ...	203

4. *Increase in office work.*—It goes without saying that these favourable results and the general extension of the scope of work, as shown in detail in the succeeding paragraphs, have been attained only by much sustained effort and hard work; one phase of this is shown strikingly in the great increase in the volume of correspondence dealt with. The following statistics of the papers registered inwards and outwards show some part of the increase in routine work falling upon the office staff at Tuticorin. Every one of these papers has to be considered or approved of by myself, so it can be well imagined from this how difficult it is for me to spare time for research work—the special duty, I take it, of my original appointment.

Official year, i.e., 1st April to 31st March.	Number of references sent out as per the outward register.	Number of references received as per the inward register.
1913–14	861	912
1914–15	1,281	1,532
1915–16	1,832	2,094

5. *Progress of the chank fisheries.*—During the past year the chank fisheries have developed most satisfactorily. Both the Tinnevelly and Rāmnād fisheries have more than doubled in production, and this, in view of the bitter competition for labour which exists between Government and the Ceylon chank merchants, is particularly gratifying. It means that the divers of Kilakarai, who are the men concerned, have come to appreciate and respond to the fair and just treatment and good wages received at the hands of this department. Last year these men were full of suspicion and distrust—the result of malicious stories spread with a view to dissuade them from entering Government service. These men know now from their personal experience how utterly false these stories were and as a body have expressed themselves as anxious and willing to work regularly for Government at future fisheries. They have been enabled by this department to emancipate themselves, so far as Indian waters are concerned, from the system of pledging their services to boat-owners in exchange for cash advances. They now work as free men receiving

their full earnings daily and their ambition is to see the end of the old indebtedness and thus to obtain their freedom in the Ceylon fishery as they have now attained it in the Indian one. This result is one for congratulation as well from the narrow view of Government revenue as from the broader one which takes account of the economic advancement of the fishing community.

Out of some 600 divers belonging to Kilakarai, some 350 attended this year's fishery ; next year I believe the number will be further increased, provided the men be not deterred by unfair means. With such increase in the labour force the produce of the fishery will advance concurrently.

7. During the fishery season now ending a considerable amount of prospecting for new beds was carried out, and I was fortunate in being able to locate some rich chank ground north of Adam's Bridge, i.e., between Danushkodi and Talaimannar. This new bed I hope to exploit next season ; in addition, I have arranged with a number of the more energetic Kilakarai divers to attempt the opening up of the beds which, we believe, lie outside of the islands off the Kilakarai coast and which have never been fished within living memory. The prospects for a largely increased production of chanks in the coming season are very good and I have every hope that we may then harvest from the Rāmnād beds over half a million chanks as against the $3\frac{3}{4}$ lakhs obtained this year. What will further help the great financial success I expect next season is the circumstance that the sale price of this quality of shell has appreciated fully 25 per cent during the current year and that next season we shall benefit to this extent from this rise.

8. The success already attained is particularly gratifying to me personally as it amply justifies the arguments I set before Government when I recommended the acquisition of the Rāmnād chank fishery. The difficulties experienced and small profits obtained during the first two years of working caused, I fear, some doubt to arise in the mind of Government as to the wisdom of my advice, but the great advance in the present year's gains demonstrate that my recommendations were sound, and that the undertaking is and should continue to be eminently profitable to Government.

9. The Tinnevelly chank fishery showed equal progress. It will yield not less than Rs. 24,901 of net profit this year, which compares notably with Rs. 10,305 of the preceding year. This good result has been attained principally through the success that has attended my efforts to recruit additional labour from other districts. Owing to the feeling among the Tuticorin divers that the pay given is too low to be remunerative, the diving force has suffered steady diminution year by year for several years past, and the salvation of this fishery appears to have been found in the willingness of a section of the Kilakarai men to join the fishery now that their distrust of Government service has been allayed. Till the present season Kilakarai men never fished at Tuticorin and the fact that I was able to induce 25 Kilakarai men and 5 Arabs to join the fishery has been the means of making good, in great part, the defection of the Tuticorin men ; it marks, I believe, the beginning of an era of increased prosperity,

provided some increase in pay be given, for although these recruits have found the work sufficiently profitable, and express themselves particularly well satisfied with the treatment meted out to them, there is some doubt if they will return if the pay be not raised, as they get double the Tuticorin rate when they work in their home waters (Kilakarai), and also because, from their newly acquired experience of the Tuticorin fishery, they have good hopes of finding the hitherto unworked deep-water beds off their own coast as profitable in the numbers of shells available for fishing as the beds off Tuticorin. I doubt, however, if the quantity fishable in the former place is so great as they expect, but as the pay is so much better, this will compensate for smaller catches. Hence to retain, as is necessary, their services in part for the Tuticorin fishery, and to bring back the local men who have drifted to other occupations, I am strongly of opinion that the time has now come for a reasonable increase in the rate paid, if the prosperity of the fishery is to increase as it ought. If this be done we shall also be enabled to recruit larger numbers of the Kilakarai divers, in which case (and it is only a question of a small increase in the rate of remuneration) there is no reason why instead of the present $2\frac{3}{4}$ lakhs produced by the Tinnevelly beds, these should not yield double this quantity.

10. Demand from the Calcutta chank market at present is good and competition keen for any contracts that are open. The Tanjore chank fishery, formerly let on a three years' lease ending 29th February 1916, for a payment in kind of 12,000 shells annually, has been re-let for another three years' term for a rent of 42,000 shells per annum; the bulk of these rental shells have in turn been sold forward for a term of three years, at the rate of Rs. 141 per 1,000 as against Rs. 55 per 1,000 formerly paid. On this basis the Tanjore fishery will eventually produce a net revenue of Rs. 5,922 per annum. Here again we have attained at last a satisfactory return to the old era of prosperity which closed in 1826 when the fishery was sold for Rs. 5,444 per annum. Between 1826 and the present time only once did the fishery bring in Rs. 2,500 while from 1866 onwards till now never did it rise beyond Rs. 750 per annum.

11. The firmness of the Calcutta market makes it certain that the Rāmnād contract now under negotiation will be concluded at a greatly enhanced rate, as offers much higher than the present contract, shortly to end, have already been received.

12. The chank fisheries belonging to or leased by this Government have now been brought to a condition of prosperity never before equalled, and if the present generous policy in development be continued and extended, the net profit to Government will certainly be very greatly enhanced. As showing the growing importance of this branch of fishery work I may point out that the sum of Rs. 60,691 was paid into the Treasury on account of chanks during 1915–16, and that this sum will in turn be exceeded in 1916-17, is already assured by the stock now ready for delivery in the Government godowns at Tuticorin and Rāmēsvaram. I am quite satisfied that within three years a return of a full lakh of rupees will be produced by these fisheries.

13. The Pearl Fishery brought in the modest sum of Rs. 2,000 net revenue, the amount at which the Tondi Pearl Banks were leased to a Nagore merchant. So far I fear his venture has not been a success, as the inducements he offered to divers proved inadequate to attract their attendance at his fishery. Very few divers attended and I am informed that the fishery lasted for eight or nine days only (April 1916) and produced barely 5,000 oysters. The lessee hopes to have better fortune in September. It appears that a considerable proportion of the younger oysters left upon the ground fished in 1914 have survived—a gratifying fact, as it confirms my belief that Palks Bay is the nursery of the pearl oysters which from time to time re-populate with their spawn the more profitable banks located in the Gulf of Mannar.

14. Pearl oysters were also found in $5\frac{1}{2}$ to 6 fathoms off Rāmēswaram during the chank fishery, and this source I hope to draw upon for material when the Krūsadai Pearl Farm be completed.

15. Inspection of the pearl banks off the Tinnevelly coast was again hampered by the absence of the Inspection Schooner "Lady Nicholson", which was on War Service at Madras till November 1915. Overhaul and repairs detained the vessel in Madras till the end of March, and when she arrived at Tuticorin the inspection season was ending. However by the utilization of the motor launch "Sutherland", the principal banks off Tuticorin were inspected; the result was as last year—an absolute dearth of pearl oysters thereon.

16. On one occasion, however, when a bamboo buoy placed on Rolikunjutavu chank bed (near the Tholayiram Par) on 17th December 1915 was removed on 22nd February 1916, great numbers of undoubted pearl oyster spat were found, showing the first favourable sign of a pending re-population of the banks seen for several years.

17. *Krūsadai pearl-culture station.*—During the past year the revenue authorities placed this department in possession of Krūsadai island. The acquisition value assessed as compensation to the former owner (the Raja of Rāmnād) was Rs. 4,882, but against this I understand that he has appealed. The island when surveyed was found to measure 107·7 acres in area; two cocoanut topes comprising 972 trees in or near bearing and 287 young ones form the only cultivation. These plantations were in a very neglected condition when taken over and will cost considerable expense and much trouble to bring into a satisfactory state. The undergrowth is now being cleared away, the trees earthed, paths made, wells dug, and efficient watering organized. With attention and care the trees should yield a remunerative return in the course of a few years.

The final plans and estimates of the buildings have not yet been received from the Executive Engineer.

18. *Sea fisheries other than those for pearls and chanks.*—Considerable increase in our knowledge of the methods and requirements of our local fisheries was gained during the year, together with some valuable data, yet to be worked up, in regard to the life-histories and parasites of our food-fishes, edible crustaceans and shellfish. The latter will be referred to further under the heading "Research." Work was continued upon the surface circulation of water in the local

seas, and valuable facts are beginning to emerge from the data already collected.

19. *Fishery Legislation.*—With the intimate acquaintance now being acquired with the conditions under which sea-fishing is carried on upon our coasts, it becomes possible to single out here and there those methods which are pre-eminently destructive or otherwise objectionable; it is however impossible as yet to frame any general fishery regulations governing in detail the sizes and forms of fishery apparatus throughout the Presidency; as Government wisely desire to do nothing to limit or restrict sea-fishing except upon evidence the most direct and irrefutable, the procedure thus necessitated is to introduce from time to time regulations touching particular methods or practices. The first of these to be framed is one published under the Indian Fisheries Act, 1897, in the *Fort St. George Gazette* of 31st March, 1916, whereby the practice of placing trees and bushes in the sea for the purpose of attracting fishes is placed under the supervision and control of the Superintendent of Pearl and Chank Fisheries; this fishing device is prevalent throughout the Indian waters of Palk Bay and is objectionable in several ways—as an infringement of the general fishery freedom of the sea, as dangerous to navigation, and as interfering in certain places with the proper prosecution of the chank fishery. In future, licenses for the placing of these fixed engines must be obtained and by this means this method will be regulated and limited to those places where its employment is not objectionable. Other regulations are under consideration, but in a country so conservative as India progress in regulative legislation is particularly slow and difficult.

20. *Steam trawling.*—Evidence based upon experiments instituted by the writer some years ago was published during the year, showing the great potentialities possessed by the vast area within the 100-fathom line (approximately 4,000 square miles) lying off Cape Comorin, for profitable steam trawling when once certain difficulties connected with transport to inland markets can be overcome. Practical progress is however held up at present owing to the financial stringency entailed by the war; meanwhile plans are being elaborated while designs and specifications have been obtained from home for a vessel constructed with a view to subserve extensive and prolonged experiments upon a commercial scale as well as to serve other urgent fishery requirements. We shall thus be in a position to proceed with this investigation, which is, I believe, the most urgent and by far the most important of all present fishery problems, as soon as circumstances again become normal. India is crying aloud for the inception of new industries and here is one which if successful—and the omens are all favourable—should open up a new and almost inexhaustible source of food supply.

21. *The deep-sea fisheries off Negapatam and the migrations of the Sardine*, together with the causes of the deplorable failure of this fishery on the Malabar coast in 1915–16, still remain uninvestigated, owing to the inadequacy of the marine biological staff to find time for these investigations. The enquiry into the causes of widespread local mortality of fishes has been however advanced to some extent, and its cause found to be, in the instances investigated, the

presence of immense myriads of excessively small protozoans belonging to the family of peridineans, associated in certain localities with multitudes of infusorians allied to the well-known *Paramœcium*. These latter appear to feed upon the peridineans and to emit an intolerable odour, indistinguishable from that emitted by the putrid refuse of ill-kept sardine-oil factories. The peridineans when occurring unmixed give a bright pink-red tint to the sea-water and patches of this "red water"—wholly different in tint from the brown-red of water discoloured by the presence of the pelagic alga *Trichodesmium erythraea*—were observed several acres in extent, and had a vertical extension of several feet. The predatory infusorian on the contrary, as it grows in size, tends to rise to the surface, where it forms a pale pea-green scum. Local fishermen believe it to be pearl oyster spawn, as the individuals when massed are distinguishable to the naked eye, so comparatively large are they.

22. *Fishery statistics.*—A four years' investigation of the Tuticorin fish supply was completed last year. The tabulation of the results has proved most illuminative and it became possible for the first time to trace with exactitude a fishery curve for each of the local food-fishes and to assess their relative importance in the food supply of the district. By far the most important are *valai* (*Chirocentrus dorab*), sardines, and rockfishes, taken in the order named. If similar statistical enquiries were to be conducted at a number of selected ports in other districts, we should obtain a mass of exact information that would be of the greatest possible value in the future development of our fisheries. The Tuticorin results have been tabulated in a series of graphic diagrams and will be ready for publication at an early date.

23. *Fish-farming.*—The fish-farm at Tuticorin referred to in last year's report was completed at the beginning of the last financial year, and we have had therefore a full year's experience of the value of the Italian system of fish-farming under Indian conditions as exhibited on the East Coast of this Presidency. The results have proved insufficiently promising to justify a continuance of the experiment on these lines, in spite of the fact that the initial year's sales of fish and prawns grown in the farm have totalled Rs. 413–9–7 as against running charges of Rs. 541–10–4. I have no doubt that with the experience gained the farm can be run profitably, but the margin cannot be made sufficiently large to commend the system. Hence a reversion to the French system (with modifications) has been proposed, as our knowledge now points to this as being likely to prove more suitable to local conditions. New plans and estimates have been drawn up and have now been sanctioned by Government. In such a departure as this, empirical methods have perforce to be employed, and only by repeated effort and refusal to be discouraged by initial failure can the unsuitable be eliminated and a satisfactory system evolved. The existence of the farm and of the methods employed, although not the complete success hoped for, have been of great benefit to the local line fishermen, who have been enabled thereby to obtain regular daily supplies of bait, which previously they could never depend upon getting. The farm has also been able to put on the local market regular supplies of prawns from an uncontaminated source and this has been greatly

appreciated by the local European community, who previously refused (and wisely) to buy bazar prawns seeing that these supplies are liable to be obtained from sewage contaminated localities.

24. *Prawn-farming.*—As the Government cannery at Beypore often suffers during the south-west monsoon from a dearth of prawns suitable for canning, owing to the interruption of sea-fishing during the prevalence of bad weather, I suggested to the Honorary Director of Fisheries the desirability of forming a prawn-farm in the vicinity of the cannery. By this means an emergent supply would be at hand to make good any default in ordinary supplies. I was able to point to the suitability of several foreshore ponds adjoining the village of Chaliyam and within a few hundred yards of the cannery as suitable for conversion into enclosed ponds where prawns may be cultivated under satisfactory conditions. The proposal being approved, a survey has been made and working plans drawn up for the conversion of these ponds into a cultural area extending to about 25 acres, divided into two sections by a sluice way. A second sluice will control communication with the sea. It is hoped to put the work in hand immediately after the close of the current monsoon.

25. *The Pulicat oyster park* has pursued a normal course; the demand for the oysters grown there has increased appreciably, but even yet a large proportion of the public have not realized the advantage of obtaining supplies from a source which can be guaranteed as free from sewage pollution, in preference to buying from dealers over whose operations no control is exercised. As I stated in a public lecture given at the Madras Exhibition last December, I have evidence that large quantities of oysters are regularly put on the Madras market as coming from Covelong, whereas scarcely any oysters are now derived from that place; it appears certain that these so-called "Covelong" oysters come from highly contaminated waters adjacent to Madras. The danger of eating uncooked oysters grown in water charged with sewage is a very grave one and it is high time that safeguards were imposed in the interest of the public health.

26. *Bêche-de-mer.*—The trade in cured holothurians ("sea-cucumbers"), known commercially as *bêche-de-mer* and *trepang*, some years ago was of considerable importance on the shores of Palk Bay. Various causes have conduced to the practical extinction of the trade, and at present the export of this delicacy (as considered by the Chinese) is almost nil. This decline has caused an appreciable loss of earnings to a considerable section of the fishing population, so, as I cannot see any sound reason why the trade should not be profitable to curers and exporters if it be carried on honestly and efficiently, I asked for and received sanction from Government to open an experimental curing factory at Tirupalagudi, a village on the Rāmnād coast of Palk Bay, where the problems of successful treatment may be investigated upon a practical scale. So far difficulties incident to the acquisition of the necessary site have prevented a commencement of the work, but as the necessary apparatus has been collected a beginning will be possible as soon as I am put in possession of the land. I am glad to say that samples cured in a rough and ready fashion and probably considerably inferior to the

results obtainable when the new factory be available have been valued by a first-class Singapore firm at from 24 to 25 dollars per picul. As the latter weighs 133⅓ lb., and taking the Straits dollar as worth Rs. 1-12-0, the product as submitted is worth Rs. 32 net per cwt., a rate that should admit of fair profit to the curer and a good wage to the fisherman who collects the raw material. A difficulty exists in the fact that the market for bêche-de-mer is subject to considerable fluctuation, but with a product of reliable and even quality this difficulty is likely to be lessened once the brand becomes known.

27. *Chank-cutting machinery.*—The search for a suitable power-saw suited to the shell-bangle trade has been referred to in previous reports. Through the assistance of the Imperial Institute, a machine saw has now been obtained and will shortly be fitted up and tested. The supplying firm have large experience in the pearl button industry and express their confidence in the suitability of the machine for the purpose indicated. As it is of handy size and can be driven by a small electric motor, it should have, if successful, a great future as these facts, combined with its low prime cost, make it suitable to the small manufacturer who cannot afford large premises and an expensive engine requiring skilled attention. Incidently its introduction should reduce greatly the cost of the production of shell-bangles and thus enable manufacturers to pay a higher price for the raw material without entailing a rise in price of the finished product.

28. *Pearl button manufacture and inlay work.*—Although this department is not directly concerned with these trades, I am frequently asked to give expert advice to Indian manufacturers. During the past year assistance of this sort has been given to button manufacturers in Bengal as well as to the Superintendent of the Chamarajendra Technical Institute in Mysore. In the latter instance it was the question of the matching of the material employed in some old pearl inlay work. I was able to identify the pearl flakes as fragments of a Pacific Ocean Earshell *(Haliotis)* and to indicate where the material could probably be obtained.

29. Except our local pearl-oyster *(Margaritifera vulgaris)* there appears to be no suitable source of mother-of-pearl supply in this Presidency, and extensive pearl fisheries are so few and far between and the quality of the shell so poor, that no local industry can be based upon this supply. Neither have we the great perennial rivers needful for the growth in commercial quantities of any of the fresh water mussels that contribute vast supplies to the American button-factories. Without rivers of this description, the introduction of species of mussels of superior shell value to that of the indigenous species will, I fear, be unprofitable.

30. *The shell-lime industry.*—During the past year I gave attention to the various shells used in the manufacture of fine lime in the Presidency. The results have been published in a report included in Bulletin No. 8 of this department. The outstanding conclusions of practical importance are that there is no uniformity in the regulation of the industry in different districts and that some of the more important sources are either unexploited or are worked without

regularity and in a wasteful manner. Particularly is the latter abuse the case in regard to the sub-fossil shell deposits of Ganjām district. For details reference should be made to the bulletin in question.

31. *Edible shellfish.*—An enquiry is in progress as to (*a*) the value of the existing shellfish industry of this Presidency, (*b*) the means of increasing the supplies of the more valuable species, and (*c*) the possibility of introducing improved varieties from other tropical countries, particularly the Malay Archipelago and Southern China; in both these countries shellfish are much more extensively eaten than in India and great attention is given to their collection and even cultivation. This last enquiry is probably the most important and the most promising of the three, although it is beset with great initial difficulties.

32. *The economic improvement of the fishing population.*—To do anything to better materially the economic position of the fishing population is a problem so vast, varied and intricate that infinite patience is required in its treatment; it cannot be attacked along the whole line at once; only here and there, where circumstances happen to be exceptional, can beginnings be made. If they prove successful the knowledge of this fact will prove a force of the utmost possible assistance in speeding up further progress. The difficulties usually are initial and due chiefly to the prejudice of the fishermen themselves reinforced by the under-ground opposition of middlemen who dread the enlightenment of the men over whom they have hitherto had great power.

33. The organization of the Rāmnād chank fishery has brought me during the past two years into intimate personal relations with the large fishing population of Kilakarai (Rāmnād district) who are professional chank divers. They number some 600 and till recently worked in the Rāmnād and Ceylon chank fisheries on what may be called the Sammátti system. Under this system, the boatowners or Sammáttis received large cash advances from the Muhammadan chank merchants who are engaged in the Ceylon chank fisheries, and also formerly in the Rāmnād fishery before Government took up the lease. In return, the Sammáttis agreed to bring specified numbers of divers in their boats to the fishery. To do this, they in turn made similar agreements with individual divers, advancing them varying sums of money. The divers so recruited followed the Sammáttis to the different fishing rendezvous in Ceylon and Rāmnād and fished as directed, changing camp from time to time according to the progress of the season. For the shells fished, the divers received settled rates which usually appear satisfactory in amount. Unfortunately in the settlement of accounts many abuses are said to take place. To begin with, the Sammáttis deduct 10 per cent of the total catch as a perquisite or bonus and 15 per cent as boat hire. The value of the remaining 75 per cent of shells is, however, not paid to the men but is booked to their credit, while on the debit side is entered a host of items for food supplied, fines, interest on the advanced money, and a proportion of all charges incurred by the Sammáttis. The divers never see the Sammátti's books, and they allege that the system is worked so to their detriment that they remain hopelessly in debt

however good be the season's fishery. Particularly harsh is the deduction of 25 per cent for boat hire and "bonus". The absence of written agreements and of receipts for moneys paid, etc., play into the hands of unscrupulous Sammáttis and there is no doubt whatever that the divers were (and still are in large degree) the debt-bound slaves of the boatowners.

34. This system seemed so pernicious that, as soon as I understood it, I resolved to break it up so far as India is concerned in the interest of the divers themselves. Hence my negotiations, so far as possible, were with the individual divers, and when their confidence was at last gained, they have been eager to co-operate. At the last Rāmēswaram fishery, the Sammátti system has been almost entirely eliminated; the Sammátti has had to content himself with reasonable hire for his boat and now he gets no perquisites of any sort. As the divers require money-advances for the support of their families when leaving home, these have to be given, but a small pass-book is handed to each man in which the original advance is entered and in which all subsequent repayments have to be noted. No further advance is given except a small weekly sum of As. 14, per head, till the total sum is recouped. When this is done, the diver at once receives daily payment *in full* for all his catch. He is left to settle independently with the boatowner whose boat he uses for its daily hire. As a consequence, local boats are largely employed as these can usually be had at a cheaper rate than those belonging to the Kilakarai Sammáttis.

35. So beneficial has this reform been that the divers would like to see it extended to their Ceylon work, and many have been their requests that Government would take up chank-fishing in Ceylon waters, in order that the pernicious Sammátti system may be extinguished in its entirety. Unfortunately a considerable number of divers are so deeply indebted to the Sammáttis, that they were prevented by the latter from working for Government this year, and it will be difficult to devise methods to liberate those men from their bondage.

36. Even more hard is the position of many net fishermen on the Rāmnād coast. These men are almost entirely in the hands of fish-dealers who by this pernicious system of cash advances hold the men in practical slavery and impose such exceedingly hard terms upon them that their life is mere existence and a continual struggle to keep from starvation. For the advances given, the fish-dealers take 25 per cent of the men's total catches *without any payment or credit whatever*, and purchase the remaining 75 per cent at low prices fixed by themselves (the dealers). Even for this balance only a little cash passes, as the bulk of the value is booked against the debt and interest thereon. Frequently too, the dealer requires the fisherman to buy his rice and salt from him at prices considerably above those ruling in the bazar. To the problem of how to ameliorate the hard lot of these fishermen I am now paying attention and I have hopes that it may be possible to render them assistance by means of local co-operative credit societies. I have already selected a fishing village on the Rāmēswaram coast where the conditions are somewhat favourable and

during the coming year, I hope to be able to effect a beginning with the aid of the local Roman Catholic parish priest who promises his aid and is keen upon the betterment of this section of his parishioners. The chief difficulty in introducing the co-operative credit system among fishermen is their lack of landed property; in the case named, the men have small holdings and this I count upon to help on the scheme.

37. *Advances for the purchase of boats.*—During the past year a number of divers, who wished to be rendered independent of their old Sammáttis by possessing boats of their own, were assisted by money contributions. The sums advanced were restricted to amounts not exceeding two-thirds of the value of the boats purchased; to prevent loss and fraud the latter have been formally transferred to the Superintendent of Pearl and Chank Fisheries as acting for Government and registered in his name. In all, five boats were purchased in this way and I am glad to report that the monthly instalments due thereon have generally been satisfactorily met. In one case, the whole amount advanced has already been refunded. The interest charged is 6¼ per cent per annum. This assistance has been greatly appreciated and many applications have had to be refused as Government do not see their way at present to extend the system to men who are not actually engaged in the Government Chank Fisheries. Were the system extended to net fishermen, I consider that a great stimulus to the fishing industry would result and I hope that means may yet be found to overcome the difficulties which Government see to such extension.

38. *Chank fishery panchayats.*—During the course of the chank fishing season irregularities and disputes occur from time to time. As these are usually intricate and involve local customs with which the Superintendent of Pearl and Chank Fisheries cannot hope to be *au courant*, I induced last year both the Rāmēswaram and Tuticorin divers to institute a panchayat or council of elders, to decide such matters and to make rules for the sanitation of the fishery camps. The results exceeded my expectations and the verdicts were duly accepted by the parties concerned.

39. *Educational work.*—This section of work has had little opportunity for expression during the past year and there can be little hope of any increase of such usefulness till a central headquarters for the department be provided in Madras. Something however has been achieved, as the following paragraphs will show.

40. *The Madras Exhibition*, 1915-16.—For the Fisheries Exhibit, the Marine section prepared and provided a large number of items, inclusive of water colour sketches of local fishes painted from life, photographs of fishery methods, models of boats, nets and fish-sluices, a collection of chanks illustrative of the different trade varieties and local races, collections of chank bangles, etc. A large series of biological preparations suitable for teaching purposes in colleges were also exhibited; these included type collections of (*a*) the edible crabs of Madras, (*b*) typical Brachyura (crabs) of the Presidency, (*c*) Madras crawfishes, (*d*) Mollusca of Madras. Edible shellfish and those used in lime-making were also shown. For the excellence of

the exhibit, the judges awarded the Marine section a certificate of merit.

41. Two lectures upon the development of Madras fisheries were delivered by the writer in the Exhibition Hall, and at the Science Congress at Lahore, held in January 1916, a paper was read upon the races and varieties of the Indian chank. The last-named is now in the press and will be issued as one of the Memoirs of the Indian Museum.

42. *Biological and museum specimens.*—Many of the specimens exhibited at the Madras Exhibition were sold to various colleges, and others have been sold subsequently. The most popular seem to be the type collections of Madras Crustaceans of which five sets have been sold at average prices of Rs. 45 each. One of my sub-assistants has been trained to prepare these in first class museum style and as they are coloured after nature, they are admirably adapted to the use of those schools where intelligent endeavour is made to give pupils some slight acquaintance with the fauna of our seas. Similar collections of shellfish have been prepared and it is hoped to add others of sponges and echinoderms before long. The cramped accommodation available at Tuticorin is however a great handicap to progress.

43. Specimens for dissection have also been provided to several teaching institutions and in this direction I foresee great developments. All the Zoological teachers whom I met at the Lahore Science Congress welcomed the prospect of an Indian source of biological supply, and when once sufficient stock can be accumulated — which I fear cannot be till the Krūsadai Island Biological station be in being—a regular demand will assuredly be created. For the past year sales of museum and dissecting specimens amounted to the sum of Rs. 360.

44. *Technical instruction* was continued during the past year to three fishery students from Baroda and Travancore, and I continue to afford them assistance by correspondence. In addition, a general insight into local fishery problems as they now stand, was given to Mr. V. R. Duraiswami Sastri, M.A., L.T., at the request of the Director of Public Instruction, in order that this gentleman may impart an elementary knowledge of the subject to the teachers who study under him.

45. *Research.*—As already noted practical work and executive routine have bulked so largely in my duties during the past year, that research has perforce been given far too little time and attention. Several important investigations have however been kept going and two of these were completed, namely, an enquiry into the species and occurrence of shells capable of use in lime burning, and an investigation of varieties and races of Indian chanks. The latter research has revealed many interesting facts in the distribution of the chank, and shows that the two main varieties arose between the period of the upheavel which at one time united India and Ceylon by means of a solid land barrier and that of the subsequent depression which caused gaps to appear in this barrier at the points we now name Pamban Pass and Adam's bridge.

46. Other investigations on hand are those connected with (*a*) the surface drift of Palk Bay and the Gulf of Mannar, (*b*) the migrations of the sardine, (*c*) the causes of wide-spread local mortality among fishes, (*d*) the food of marine fishes and prawns, (*e*) the parasites of fishes, (*f*) the edible shellfish resources of the Presidency, (*g*) fishery statistics of Tuticorin and some others of more abstruse nature.

Regarding the causes of fish mortality I have already made reference (paragraph 21), while a summary of the Tuticorin statistics is now under preparation. Many valuable isolated faunistic observations which some day will become useful, have also been made and duly recorded.

47. *Bulletin No.* 8.—During the year the following three papers, forming the conclusion of this bulletin, have passed through the press, viz.:—

(*a*) "Professor Huxley and the Ceylon Pearl Fishery, with a note on the forced or cultural production of free spherical pearls."

(*b*) "Report on the Pearl Fishery held at Tondi, 1914."

(*c*) "The utilization of coral and shell for lime burning in the Madras Presidency."

The bulletin is now complete and on the point of issue from the Government Press.

The first paper of another bulletin has also been written and is ready for the printer; its subject is *The Edible Mollusca of the Madras Presidency*. In it is brought together all the available information upon the local shellfish which have present or potential economic value. It is illustrated with original sketches of all the important species and when printed might with advantage be widely distributed to schools situated on the sea coast in order to awaken interest in a subject of growing importance.

48. *Superior staff.*—Difficulty continues to be felt in getting satisfactory men to fill the posts of Sub-Assistants, as suitable graduates with the necessary Zoological training find the pay, Rs. 50—4—90, too low.

ORDER—No. 2764, REVENUE, DATED 5TH DECEMBER 1916.

The report of the Honorary Director of Fisheries is an interesting record of much useful work accomplished in spite of difficulties arising from the continuance of the war and from an adverse season.

2. The great scarcity of fish which marked the two previous years on the West Coast was even more severely felt in the year under report and seriously hampered operations at the experimental stations in Malabar. Valuable experiments were however carried out in connection with pickling, the manufacture of vinegar and fish glue, the refrigeration of fish and the employment of "solar ovens". The Government are glad to see that the utilization of by-products, an important factor in all commercial enterprises, is receiving due attention.

3. The financial results of the Beypore cannery, the Tānūr fish-curing yard and the Soapery were satisfactory and give reason to hope that it will be found possible to develop the industries which they are intended to promote profitably on a commercial scale. The Pulicat Oyster farm was run at a loss and it is a question for consideration whether steps could not be taken to make its products more widely known.

4. The gross receipts of the Bureau (exclusive of the pearl and chank fisheries) amounted to Rs. 78,588, of which Rs. 57,874 was realized from the fishery rentals of waters stocked by the department. This figure represents an increase of Rs. 19,463 or nearly 60 per cent on the rentals realized before stocking operations were undertaken. The most important item is the fisheries of the Cauvery and the Coleroon.

5. The Director will be requested to append to his reports in future a statement showing the total expenditure, as well as the total receipts, of the department.

6. The Piscicultural Expert, in addition to the stocking and other operations already in his charge, carried out much useful investigation work. The Government have read with much interest his suggestions for the suppression of malarial fever in the Nallamalai hills in the Kurnool district.

7. The results of the chank fisheries and the connected problems have already been reviewed in G.O. No. 2648, dated the 23rd November 1916. The Government desire the Director to consider whether the annual report on the chank fisheries might not more conveniently be treated as an enclosure to the Director's administration report instead of being submitted separately and whether anything could be done to relieve Mr. Hornell of routine work so as to enable him to devote more attention to research work.

8. A promising feature of the year's record is the establishment of co-operative societies among the fishermen of Tānūr and Tellicherry, and the Government hope that this educative and economic aspect of the work of the department will continue to develop.

Letter—from SRI FREDERICK NICHOLSON, K.C.I.E.,
Honorary Director of Fisheries.
To—the Secretary to Government, Revenue Department.
Dated—the 10th August 1917.

I have the honour to submit my annual report for 1916–17.

* * * *

3. The staff remained throughout the year as in 1915-16. Though the event belongs strictly to 1917–18, I record with deep regret the death, on the 11th April 1917, of Mr. H. C. Wilson, Piscicultural Expert, who had been in the department since November 1907 and to whose skill and energy the whole of the fresh water piscicultural work in the Presidency is due. The report for that branch has consequently been drawn up by the Piscicultural Assistant Mr. B. Sundara Raj, M.A.

4. The following is an abstract of the main operations in the several branches.

Director's Branch.—General control of the department; Tanur fish-curing yard including curing, smoking, pickling (salt and vinegar), fish oil and guano, etc.

Cannery at Chaliyam (Beypore), with experiments in solar heating.

Soap-making at Calicut and Tanur.

Miscellaneous, including tuition, socio-economic work, Bulletin writing, etc.

Piscicultural Expert's branch (Mr. H. C. Wilson).—The Sunkesula fish farm, that at Ippur, larvicidal work, the stocking of tanks, the re-introduction of Gourami, Nilgiri trout culture, the conservancy of various waters, the detailed examination of the waters of Coorg and South Kanara and of a variety of large tanks in the districts for conservancy purposes, project and miscellaneous work.

The Marine Biologist's branch (Mr. Hornell, F.L.S.).—The Tuticorin fish farm, the edible oyster farm at Pulicat, the pearl oyster culture farm at Krusadai (Pamban), the preparation of specimens for distribution and for educational work, bêche-de-mer cultivation, investigations for and writing of bulletins, research, and miscellaneous.

Pearl and Chank branch (Mr. James Hornell, F.L.S.).—Chank work over the whole coast between Madras and Cape Comorin, including the great fisheries of the Tinnevelly and Ramnad districts; chank cutting experiments, and miscellaneous work.

The above and other matters are dealt with in detail below,* the reports of the Piscicultural Assistant and the Marine Biologist being printed almost in full. The chank fishery report for the season 1916–17 drawn by the Superintendent of Pearl and Chank Fisheries, Mr. James Hornell, is submitted herewith as an enclosure to this report as desired by Government in paragraph 7 of G.O. No. 2764, Revenue, dated 5th December 1916. The accounts of the chank fisheries for the season 1916–17 have been audited by the Accountant-General and found correct.

5. *Director's branch.*—This was run directly by myself with the co-operation of the Assistant Director Mr. V. Govindan, B.A., and the Oil Chemist Mr. A. K. Menon, B.A. It includes the mass of work connoted by the expression "general supervision and control of the Fisheries Department" whether administrative, technical, or financial, and needs no special mention except that each year necessarily and rightly increases the volume, diversity, and complexity of the work. The negotiations for a new Director did not materialize and the present officer has had to carry on. It also includes the industrial sections worked at the Tanur fish-curring and oil and guano yard, the Beypore cannery, and the soapery.

6. *Tanur Experimental station.*—The year was better than in 1915–16 but not altogether favourable; the sardines were mostly small and lean as compared with ordinary years; the mackerel were unusually small, and large fish scarce. The experiments in mackerel pickled moist with ordinary salt and pickled with condiments, were developed and a considerable number of barrels and kerosine tins are in stock, partly for observation as to their keeping power, partly for sale especially during the monsoon. They are quite successful as products and are excellent when properly prepared and cooked, but, like

* Not printed in this Bulletin; the original reports may be perused in G. O. No. 285, Revenue, dated 21st January 1918.

all salt fish, as much depends upon the cooks as on the curer ; salt mackerel prepared in my own house were excellent whether plain boiled, broiled, as fish balls, or in curry, but the soldiers' cooks did not approve of them. The condimented mackerel are excellent for those, especially the poor, who only require a small portion as a relish with rice or other cereals.

7. The experiments in vinegar and glue were not continued, partly because the demands of the directorate, of the soap factory, and of the Industrial Commission gave less opportunity than ever for personal attention and for improvement of plant and methods, partly because the climate of the plains does not lend itself to either manufacture ; unless artificially cooled rooms are available the evaporation of spirit, the formation of volatile aldehyde and the inefficiency of the bacteria, render vinegar making too wasteful for ordinary profit. The matter is worth attention in the breweries of Ootacamund or the distilleries on the coast where spirit is cheap and refrigeration possible. Experiments will, however, now be continued at Coonoor where the climate is favourable, being fairly equable. Fish glue, for which several enquiries were addressed by business firms to the Director, is never likely to be a serious product since almost every part of every fish is used for food ; materials like cat-fish heads which would yield glue are particularly sought as food, and fish skins are not stripped from fish before sale, but are eaten with the fish. Certain products may however be yet availed of. But here again, the climate, and especially the moist heat of the coast, is against the manufacture of hard glue which will not set on the drying nets at our normal temperatures.

The oil and guano (fish scrap, obtained after boiling and pressing the fish for oil) continued to be of first-class quality, and there is now little difference between skimmed and pressed oil, while the guano on one occasion gave above 9 per cent of nitrogen.

8. *Cannery.*—This did better than in the previous year and 55,500 tins were packed as against slightly above half that number in the previous year ; moreover several thousand were of double or more than double the ordinary size.

9. The chief points worth mentioning are as follows :—

Cans of larger size than usual were frequently used, viz., cans holding from 24 up to 48 oz. nett of fish, as well as double-sized sardine tins ; this was partly to save tin plate, partly to provide cans more suitable than small ones for hotels, clubs, refreshment rooms, troops, etc., partly to cheapen the price of the contents. Since the contents of a can are doubled, trebled, etc., by merely deepening it (tops and bottoms remaining the same), it is evident that the cost, and therefore the price of the larger cans is relatively less than that of two or three, etc., smaller cans ; it is possible to give 24 oz. nett of fish at a price only about 50 per cent more than that of 12 oz., and consumers who require the larger quantities are thus greatly benefited.

Other fish (seer, pomfret, etc.) were canned in some quantity and have proved successful.

Many demands for our canned fish were received from all over India, Burma and Ceylon, but these, when outside of this Presidency, have been regretfully declined (except from Military and Red Cross authorities) on the necessary ground that the demands of this Presidency more than absorb the output of our experimental factory.

10. *Refrigerating fish.*—The Henderson method of freezing fish was successfully operated till the hot-pot of the engine cracked, and notwithstanding efforts, could not be replaced within the year. It is, however, to be understood that the operations are not and were never intended to be, on a commercial basis or scale ; it is a very small experimental plant intended to ascertain technical *facts*, not to make a business profit for which plant and organization on a large scale are necessary ; large plant to deal with masses of fish, and large organization first to get the quantities required and secondly to obtain and keep the circle of continuous custom necessary in dealing with such delicate material as fresh fish.

11. *Fishing boats.*—Two Ratnagiri boats were obtained and, with our canoes, brought in considerable quantities of fish. One of the boats was manned by a Ratnagiri crew, and the other by a partly local crew who were to work it as a business proposition. During some

bad weather this latter boat was seriously damaged, delay was experienced in repairing it, the crew got discouraged and abandoned the enterprise; so far this part of the idea has not worked successfully and the methods will have to be reorganized.

A motor launch was sanctioned for the cannery and station work and will probably be built during 1917–18.

12. Certain other experiments in the better preservation of canned prawns and in canning methods are in hand and will be further possible with the greater leisure shortly, it is hoped, to be available to myself.

13. From want of leisure, the solar oven experiments were not developed as intended. But the simple addition (1) of tin plate reflectors fixed on the sides of the oven at an angle of 45° so as to throw the Sun's rays into the box, (2) of a turn table and mounting which enables the glass surface of the oven to be kept perpendicular to the rays at all hours, has frequently produced an internal temperature up to 310° F. which is ample for my purpose, viz., that of stoving my lacquered tins, while it gives promise of much greater results presently in other directions; the method gives not only a higher temperature but a much longer period than formerly of the higher temperatures.

14. *Deep sea work.*—Except for the Ratnagiri boats mentioned above, which stayed out several days at a time, no real deep sea work was possible owing to the war and consequent inability to obtain ship or men.

15. *Work of the Piscicultural Expert (Mr. H. C. Wilson).*—Owing to the lamented death by cholera of Mr. Wilson at Kurnool on the 11th April 1917, the report for the year has been drawn up by Mr. B. Sundara Raj, M.A., Piscicultural Assistant. The chief operations were the Sunkesula fish farm with an addition known as the Pudur scheme sanctioned during the year, the hilsa hatchery on the Coleroon, the stocking of an increased number of tanks, the starting of the Ippur fish farm (Nellore district) mainly for larvicides and for the breeding of gourami and other valuable fish, the acclimatization of tench, the breeding of fish, chiefly Etroplus and larvicides, in a series of ponds at the old Powder Factory, Madras, where gourami are also placed, the

putting in hand of the Nallamalai scheme for the growth of larvicides in view to combat local malaria, and other anti-malarial work, and the continuance of trout operations on the Nilgiris. A considerable area was brought under the restrictive operation of section 6 of the Fisheries Act (IV of 1897). Apparently the fishermen have it their own way in the Colair lake and Upputeru rivers for which Mr. Wilson had a promising scheme which, however, is useless if the fishermen cannot be controlled in the matter of stake nets and fixed engines. Mr. Wilson and his staff did a great deal of inspection and work not easily recorded; among Mr. Wilson's inspections were detailed and lengthy tours in South Kanara and Malabar in view to schemes for stocking and conserving the West Coast rivers; this is mainly lost labour by reason of his death. He also visited Java and successfully brought back a consignment of gourami which are of great value.

The Piscicultural Assistant was busily engaged throughout the year in inspection and supervision, and in making himself acquainted with the work of his branch, the conditions of the country, and the operations in progress; he was also in charge during Mr. Wilson's absence in Java.

Sub-Assistant C. G. Chakrapani Ayyangar, B.A., is reported to have done useful work throughout the year both in actual piscicultural operations, in attending the numerous fishery rental auctions, and in supervising office work. The bulk of the report is printed in the Appendix.*

16. *Pearl and Chank Fisheries and Marine Biological work (Mr. James Hornell, F.L.S.)*.—†Pearl and chank work was carried on as usual but with a larger net profit (Rs. 46,400)—entirely from chanks—than has ever yet been attained except when a regular pearl fishery has happened; nothing was received from pearls during the year, for not a pearl oyster was ever in sight. Mr. Hornell's exertions in chank fishery matters brought about the increased yield from chanks, which, however, would have been far higher had a larger diving force

* Not reprinted in this Bulletin; see G.O. No. 285, Revenue, dated 21st January 1918.

† For the full report see G.O. No. 285, Revenue, dated 21st January 1918.

been available for the Ramnad fisheries and had the weather been more favourable for those of Tuticorin. Mr. Hornell's lagoon fish-farm at Tuticorin, his biological specimens sold to various colleges, and his revived bêche-de-mer industry all yielded substantial profit, but the Pulicat oyster farm showed a small loss, partly for reasons given by Mr. Hornell, partly because it is only on an experimental and not on a commercial scale; it is an experiment intended primarily to obtain piscicultural data and only secondarily to market the products. For real commercial work the farm would have to be on a far larger scale and probably in a different locality, with an outlet for surplus products by way of canning or preparing oyster (and mussel) extracts.

The plans and estimates for the projected Krusadai pearl oyster farm off Pamban were laid before Government; though costly (Rs. 50,500) at start, it should prove a most lucrative investment; apart from Mr. Hornell's special aims we know from Japanese experience the possibilities of the methods to be adopted at Krusadai; to repeat what I have said elsewhere, we are likely to obtain continuous annual returns on a considerable scale from a controlled mass of pearl oysters in our fenced farm instead of very occasional (now very rare indeed) returns from chance deep-sea natural fisheries where conditions are absolutely beyond human control.

17. In accordance with paragraph 7 of G.O. No. 2764, Revenue, dated 5th December 1916, reviewing my last year's report, proposals have been sent up to Government for reducing Mr. Hornell's routine work so as to give him more time to apply his scientific knowledge in various directions.

18. *Socio-economic work.*—(Mainly by Assistant Director, Mr. V. Govindan, B.A., F.Z.S.) The formation of co-operative societies took up a good deal of the Assistant Director's time and energy, this work being of extraordinary difficulty among fisherfolk, so much so that Mr. Hornell is not sanguine of present results in his locality, as shown in his report printed below. Three societies were in existence at the beginning of the year on the West Coast and four more were started during the year, with preparation for several others of which four have since been formed. One of these was at

Mangalore and resulted partly from the work of the jnanodaya Samaj, as suggested by Government when sanctioning a grant-in-aid to the building of a meeting hall for the society, but the co-operative society is a separate entity from the Samaj and includes outsiders. On the East Coast the Assistant Director laid the foundations, as he hoped, at Uppada for a society, but the Assistant Registrar has subsequently stated that the people, especially the younger men, entirely refused to take up the idea. I suppose that there is no class in the world who would be more benefited by co-operation in its various forms, productive and distributive, than the Indian fisherfolk, and no class which presents greater difficulties to the reformer. It is not merely a question of education but of habits and customs resulting from heredity and environment and the conditions of their life and livelihood. Hence we are going to take this up far more intensely than before.

(*a*) The fate of the Temperance Society at Malpé mentioned last year, is a case in point; of purely local origin, it had a membership, mostly of very young men, of 70 with a fund of Rs. 700, which led to suggestions for its development as a co-operative society. But owing to the youth of members it became necessary under the Act for their natural guardians to become members, and these, seduced by the existence of the deposited funds, compelled their sons to withdraw from the temperance society, taking their money with them. Hence the society has been (temporarily) wrecked, but it is hoped to restart it. In a previous year I reported that the parents of members of a temperance society were its chief opponents, owing to the existence of ancestral drinking habits; the present case displays another rock of stumbling. *Per contra*, it is pleasing to note that the young Tellicherry Co-operative Society, which now has about Rs. 1,500 in hand, was able to assist some of its poor members by small loans to tide over the monsoon season when, owing to the previous bad fishing season, they had no funds; most of these loans were repaid as soon as the new fishing season began. This incident is an excellent object lesson in one of the direct benefits of co-operation. A co-operative fish-curing society is in process of formation at Thalayi near Tellicherry, and

the papers have gone up to Government for a grant of funds.

19. *Education* is, like co-operation, assuming a larger position in our work ; the school attached to the yard at Tanur had 30 boys and earned a grant of Rs. 116 during the year ; it is run by our yard staff who also teach carpentry and smith work. Two evening schools were started by the fisherfolk at Thalayi and Kuriyadi, and by courtesy of the Collector of South Kanara, we secured a site and an old building at Mangalore where a school is about to be opened. The Jnanodaya Samaj at Mangalore is also doing educational work in addition to its social reform work, and on this department's recommendation, Government gave a half-grant towards the building of a hall for their use. In G.O. No. 16, Education, dated 3rd January 1917, disposing of correspondence relating to the starting of schools for fisherfolk at Mangalore and Malpé, Government requested the Director of Public Instruction to consider, in consultation with this department, the question of the extension of elementary education among the fisherfolk ; the Director accordingly wrote to me on 1st June 1917, making certain proposals which are now (July) under consideration ; this should lead to systematic work. Pending disposal of this matter it may be said, at once, that while on the one hand as already stated in my letters read in G.O. No. 16, Education, dated 3rd January 1917, Fishery Educational Institutes (as understood in Great Britain, Belgium, France, the United States of America, Japan, etc.), are not within measurable distance, yet on the other hand fishery schools, as foreshadowed in my letters and quite different in methods and teaching from ordinary elementary schools, are an immediate desideratum.

The Assistant Director also conferred with the trustees of a large endowment for education at an East Coast port and is hopeful of special seeing schools started.

20. *General.*—Two unusual and important events marked work on the West Coast, viz., His Excellency the Governor's visit to Calicut, Beypore (cannery) and Tanur fish-curing yard, and the visit of the Indian Industrial Commission to Calicut when they also inspected the cannery and soap works. His Excellency's visit was

most encouraging both to the department and to the fisherfolk who were not only able to interview their Governor but to note his personal interest and that of his Government in the welfare of these poor and seldom visited folk -

(*a*) The war unfortunately affected these folk in that though the saradine season was not unfavourable in North Malabar and South Kanara for the manufacture of oil and guano, yet the absence of freight so destroyed the demand for their products that they fell to a very low price and have largely remained, especially oil, on the hand. At the low price of the fish guano, it should be taken up entirely for the agricultural needs of the Presidency.

(*b*) The number of private oil and guano factories was 253; two large European firms entered on the business of manufacture, and this should produce improvements. The season was bad for this manufacture in South Malabar but good elsewhere.

(*c*) An important proposal was made to Government by this department to take over all the Government fish-curing yards (so-called) from the Salt Department and work them more or less after Tanur methods; the matter is pending disposal since other difficult questions are bound up with it.

21. *Enquiries.*—Apart from the ordinary business demands, a considerable number of serious enquiries were made as to products and processes. Two related to fish glue and the preparation of "fish maws" for market; several to the canning and curing of prawns; others as to oil and guano manufacture and the use of fish guano as manure. A large order has been placed by the Cawnpore Harness and Saddlery factory as the result of our samples of fine oil. During the year a circular was sent to various Agricultural bodies and mercantile firms pointing out the value of fish guano; one result was an order through the Deputy Director of Agriculture, Trichinopoly, for four tons for a Co-operative Manure Society in Tanjore (Nidamangalam); many other agricultural inquiries were also received and the addresses of local firms supplying the manure (and oil) were furnished. It is absurd that it should pay Ceylon and even Japan to import our fish guano when

we ourselves grow in abundance rich products such as tea, tobacco, etc., for which fish manure is pre-eminently suitable. It seems, however, that a good deal is going from South Kanara to the Bombay Presidency which is a hopeful sign. Enquiries were also received and answered from various authorities (Salt, Jail, etc.), and private persons as to the cure and preservation and also the supply of fish, both salted and fresh. Two firms from other Presidencies also enquired about the solar oven and requested drawing, etc., these will be furnished when the matter is more developed and time permits. Enquiries were also made for leaflets or other literature on fish-curing, etc. ; this indicates a want which I propose to meet by the frequent issue of brief papers as distinct from the more complete papers hitherto drawn up or contemplated ; such papers would deal with the treatment of fish from capture to beach, market or curing yard ; with certain curing methods ; with drying ; with cleanliness and sanitation ; with the proper preparation of oil and guano ; with fish culture on the pond system, and so forth ; apart altogether from socio-economic tractates which are much needed.

References were also made as to the improvement of oils for export and local use ; the Industrial Commission spent considerable time in its enquiries into the work of the department including also the soap works, and examined myself and the Assistant Director at length.

An important reference on the possibility of commercially manufacturing "Meat extracts" in India was received from the Military authorities and answered, the reply being decidedly in the negative. It may be possible to produce, on a small scale, extracts from oysters and mussels which are not very general articles of food in this country, but not meat extracts.

Another reference was connected with the extraction of a certain vegetable fat—by chemicals as opposed to mechanical expression—and this also was answered in the negative.

A great variety of miscellaneous references were received including some of a tenor much as follows :—

"I desire to start a soap factory (or cannery, or fresh fish trade) and wish to be informed of details of the various processes, the materials used and where

procured, the best locality for a factory, and what profit may be expected." Such letters are important not so much as showing enterprise but as displaying the extraordinary and light-hearted ignorance of enquirers who, quite genuinely, think that they could be instructed offhand by letter in a complicated manufacturing industry, involving a large knowledge of applied chemistry, technology, and trade. Such inquiries, as well as facts relating to the stagnation of industrial enterprise, show the necessity for Government experimental and demonstrational factories like those of this department where, on behalf of such genuine inquirers, Government may, on approved industries, legitimately spend State money without expectation of commercial profit as a necessary primary result, first in ascertaining facts, processes, markets, etc., and then in giving thorough instruction to men prepared to spend capital and energy in starting private factories with real knowledge of the work. This is the basis of my reply to the Industrial Commission who have asked whether Government factories should be handed over to private enterprise when they had "made their proofs"; I reply in the negative because the first duty of the Government factories is experiment; the second is general demonstration, and the third advice and full instruction. Even in the presence of great factories, should such be established, Government factories may long be needed in order to teach and advise the smaller folk, to promote small enterprise alongside of large, to prevent monopoly and secret exclusiveness, and to provide skilled artizans and foremen, instructors and inspectors.

22. *Soap works.**—Soap manufacture is reported on here because it has been placed personally under myself, and because in one branch it uses the fish oil made in our Tanur station and elsewhere. As explained in last year's report, fish oil is only used for insecticidal soaps used on plantations and estates, and forms no part whatsoever of soaps used for household or toilet purposes.

23. *Fish oil soaps.*—Only 12 tons of this Tanur product were made and sold in the year as against 25

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* From 1918 the report on this branch will be separate.

in the previous year. This was partly owing to less demand due, as actually stated to us, to a diminution of consumer's estates of insect pests, partly to a reduction on estate expenditure, partly to our forced economy in caustic soda which, as an imported article, immensely increased in price and during the latter part of the year when we began ordinary soap making, was no longer procurable; hence our small stock was reserved for the higher-priced household, etc., soaps made in the Calicut factory. The soap however continued to be in demand and many orders which could not be executed were received. Its insecticidal power is thoroughly recognised and its usefulness extended especially to the destruction of the "mango hopper," of coconut pests and even of ticks on cattle and sheep; it is said that the mango crops were immensely better in cases where this soap was used.

11. *Soap works for ordinary household and toilet soap.*—This was solely made at Calicut where a temporary factory was, after considerable search for a suitable site, started in a rented building which was formerly our cannery; it is but a makeshift but it was thought wiser not to await the building of a permanent factory which would have occupied at least the whole year so that we should have lost the financial grant and a year's experience and profits, while it might have been located, by reason of haste, in a wrong locality; other uncertainties such as the possible erection of a complete technological institute elsewhere for the oils and fats industries also had weight.

(a) On the grant of funds for 1916–17 towards the close of the previous year, the toilet soap and glycerine plant with other machines (steam crutcher or mixer, pumps, pipe coils for steam drier, slabbing and barring machines, etc.) were ordered from a great maker in England; the toilet soap plant and other machines as ordered being standard were fortunately in stock, and after much shipping delay, were received at the end of October; the glycerine plant cannot at present be sent owing to the war. The remaining plant (3-ton soap pan, soap presses, soap frames for the hot and cold processes, steam drying chamber and trays, iron tanks, etc.) were made locally, as Mr. Menon, the Soap Expert

and Manager, was able to give, designs for them. The alterations to the building, the making and eventual setting up of the soap pans and other locally made plant, the obtaining of a large steam boiler from the Public Works Depot, Madras, the purchase and collection of raw material, and the delays caused by the continuous monsoons of the West Coast were more or less over by 15th September when work actually began. The toilet soap plant and English machines arrived only at the end of October but notwithstanding the difficulty of getting an engine and of fitting up shafting, etc., this interesting part of the plant began work about the middle of December. Hence the soap factory for household soap was only at work, more or less haphazardly at first, for 6½ and the toilet plant for 3½ months during the year under report. In considering results both as to quantity and quality the smallness of the plant, the novelty of the conditions, the necessity for training a working staff from the very commencement and in the A B C of work, the makeshift character of the factory building and of some of the plant and above all, the shortness of the working period, must be remembered. That the plant was in fact made and put together and the staff trained so quickly and gave such good results from the beginning is a tribute to Mr. Menon's zeal and capacity.

35. With the approval of Government the general name or brand adopted for our soaps is "Chirian," the several varieties having their own specific name such as "Washwell" for domestic soap, "Cobra" for a special disinfectant soap, "Vegetol" for a toilet soap which contains only vegetable oils (whence its name) and no animal fat whatsoever. The toilet milled soap is made from a special soap base which also contains no animal fat, and is therefore also a vegetol soap. But as subsequently prepared, like all milled toilet soaps, by special drying, perfuming, milling, etc., in form and cases of high class soap, bearing different names according to colour and perfume, treatments etc. A characteristic of all our soaps, even of "Washwell," is their lathering power which enables them to be used with hard and brackish waters, as even in Coimbatore. So also the perfumes used are all indigenous and as far as possible, those popularly approved such as sandal, [illegible], etc., this feature is

being specially developed. Finally, it is to be noted that the soaps are wholly genuine, unadulterated soap without any fillings or excess of moisture; they are intended as experiments in genuine goods and as object lessons for future local manufacturers.

It will be seen that we are satisfying the objects on which we started, viz., pure, cheap soaps, suited in every respect to the various classes of Indian consumers, especially those who desire soaps of purely vegetable origin, and suited to the waters in which they will be used.

26. During the period of work about 32 tons 'Washwell' and 12 tons 'Vegetol' were made; more was not then possible as the manager was occupied in fitting up the toilet plant, experimenting, buying raw material, training the staff, getting business together, etc., so that actual manufacturing work was at first halting. Sales of these soaps to the 31st March aggregated 14 tons leaving about 33 tons in stock. Some of the Washwell soap in stock on 31st March 1917 formed part of a parcel of 40 tons delivered to the Military authorities by June; the rest of the stock of all soaps was readily sold out. Vegetol has obtained a great vogue and is sold as fast as it can be made, owing to its composition, lathering qualities, etc. The milled toilet soap is also growing in favour. "Coaltar" soap is much in demand owing to its purity, cheapness and disinfectant qualities; considerable sales, with constant repeat orders, are being received, especially from the Military authorities, Red Cross Associations, and others.

27. *Glycerine.*—As the recovery plant from England could not be obtained, though partly paid for and the order accepted, glycerine could not be properly dealt with, a serious misfortune since this article may easily enable us to sell soap at cost price and yet obtain a substantial profit. Use was made of solar evaporation and with some success, a few hundred rupees worth of crude glycerine being now in hand, but the matter requires much further examination and better apparatus which will now be provided.

28. His Excellency the Governor visited the factory in October, but the toilet soap plant and other machines had not then been received. The Industrial

Commission visited the works in January. Opportunity was taken to exhibit side by side with our genuine soaps certain filled soaps from other countries, and soaps specially faked in our own factory, containing less than 20 per cent of fatty acids instead of 60 or more as in our genuine soaps, yet in appearance, smell, etc., of a character which would entirely deceive ignorant purchasers ; it is perfectly easy to make soaps of fairly good appearance which are not soaps in the proper acceptation of the word and are not worth even the cheap price which might be put on them.

29. *Laboratory.*—It was not found possible to form a laboratory on account of war disabilities, but small quantities of apparatus and re-agents were, by courtesy of the Indian Institute of Science, lent to us, and these have been of value. With a fairly good laboratory we could satisfactorily answer references made to us, as in the year, by business firms and others, deal with our daily problems in testing the oils and materials which we use, and, above all, test the adulterated oils and fats, including ghee, now used as edibles, and the soaps now supplied to the public.

30. Several applications, some well supported, for admission to the soap works as students were received ; but for the present it was impossible to accede to the requests as we are still in a very experimental stage, and, moreover, have no facilities for teaching. This must stand over for the present. There have been many visits, however, by the public such as bodies of students from the Agricultural and Forest Colleges at Coimbatore ; from various Arts Colleges outside of the district, and from all local educational institutions including girls' schools. Various Government officials also visited the works, including the soap expert and an engineer from the Department of Industries, Mysore, who were permitted to spend several days taking drawings of the various items of plant, especially the toilet soap machines.

31. The soap is readily saleable, and many applications have been received for sole agencies, and even for our whole output. But I have, in general, adhered hitherto to the plan of selling direct to consumers, generally on the value-payable parcel system, for which

both the South Indian Railway and Madras and Southern Mahratta Railway have given concessional parcel rates. To regular firms and in larger parcels soap is sold on favourable terms, and the demand is now greater than the output which we are trying to increase. We have been gravely hampered by the absence of caustic soda, and have been forced to obtain a parcel of 30 tons from America; pending arrival we were enabled to carry on sparingly by a loan of two tons most courteously lent to us by Messrs. Binny & Co. from the Buckingham Mills.

32. *Accounts.*—Both as regards fisheries and soap works the accounts have been systematized. By the courtesy of Messrs. Binny & Co. and Messrs. Parry & Co., my office head clerk M.R.Ry. C. R. Natesa Pillai, who is a careful and experienced hand, was permitted to inspect their forms of accounts and to establish a good system; for the soap works these have been improved by recruiting a book-keeper experienced in trading accounts; these exhibit every detail, and the profit and loss accounts may therefore be relied on as business statements. As the accounts are now being professionally audited in view not only to ascertain their correctness in form and fact, but also to obtain any suggestions for their improvement, a supplementary report * dealing with the financial position of the department and of its several branches, will be submitted shortly, in time for the usual review by Government.

* Not reprinted in this Bulletin; it may be perused in full in G.O. No. 285, Revenue, dated the 21st January 1918.

Order—No. 285, Revenue, dated 21st January 1918.

Miscellaneous.	Recorded.

2. *Director's branch.*—The fishing season was on the whole more favourable than that of the preceding year. The outturn of the Beypore cannery more than doubled that of 1915–16. Several useful experiments were successfully carried out at the Tanur experimental station, one of the most noteworthy being the preservation of fish by freezing. The progress made in the manufacture of soap reflects credit on Mr. A. Kesava Menon; the carefully prepared accounts of the soapery show that the factory is established on a sound footing in spite of the difficulties created by the war, in particular the impossibility of obtaining a plant for the separation of glycerine.

3. *Marine fisheries.*—Owing to unfavourable weather and difficulties in obtaining divers, the number of chanks fished fell much below the record of the previous year. The falling-off was particularly noticeable in the Tinnevelly, Ramnad and Sivaganga fisheries. The increase in prices realized, however, yielded a net profit (exclusive of supervision charges and taking into account the receipts up to 30th June 1917) of Rs. 52,700, a higher figure than any yet recorded. The Government have read with interest Mr. Hornell's account of the revived bêche-de-mer industry and they hope that he will be able to expand its scope. The monographs compiled by Mr. Hornell in the course of the year are a welcome addition to the information already gathered. The attention of the Sanitary Commissioner is invited to the possibilities of contamination of the oyster beds from which Madras City is supplied.

4. *Inland fisheries.*—Good progress was made in the development of inland fisheries. Tank-stocking and conservancy have already resulted in increased rentals which are indirectly an index of the increase in food supply. A comprehensive scheme for the improvement of tank fisheries for the whole Presidency is in course of investigation. The effect of larvicidal species in reducing the incidence of malaria is difficult to gauge;

the experiments are however being watched by the Sanitary authorities. The success attained in hatching *hilsa* reflects credit on the Piscicultural Assistant Mr. B. Sundraraj. The successful importation of live *gourami* from Java is a noteworthy feature of the year's work. The department has suffered a regrettable loss in the untimely death of Mr. H. C. Wilson to whose experience and practical skill the Government owe the inception and successful execution of many schemes of utility.

5. *Socio-economic work.*—The efforts made to improve the social and economic condition of the fisher-folk have not met with unqualified success, but valuable experience has been gained in dealing with this difficult problem and eleven new societies were formed by the end of June; the work done by the Tellicherry Co-operative Society and the Jnanodaya Samaj promises well for future developments. The Government await the report of the Director of Public Instruction on the proposals formulated by the Honorary Director in his letter No. 565, dated 19th September 1917.

6. *Finance.*—The Honorary Director has supplemented his report with detailed statements of the receipts and charges in the several branches of the work of his department. The results are abstracted in the subjoined statement :—

I. Director's branch.

	Expenditure.			Receipts.			Difference.		
	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.
(1) Beypore cannery.	14,312	9	10	19,902	2	4	5,589	8	6
(2) Tanur yard.	5,167	14	0	5,915	11	10	747	13	10
(3) Soapery ...	55,990	2	2	57,759	13	3	1,769	11	1
Total ...	75,170	10	0	83,577	11	5	8,107	1	5

II. Marine fisheries.

(1) Chank and béche-de-mer fisheries up to 30th June 1917.	34,608	13	0	88,547	4	4	53,938	7	4

II. Marine fisheries—cont.

	Expenditure.			Receipts.			Difference.		
	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.
(2) Pearl fisheries.	...			655	0	4	655	0	4
(3) Tutcorin fish farm.	552	15	8	897	1	0	344	1	4
(4) Pulicat oyster farm.	805	10	0	459	9	6	— 346	0	6
Total ...	35,967	6	8	90,558	15	2	54,591	8	6

III. Inland fisheries.

	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.
(1) Piscicultural works.	10,446	12	9	148	1	3	— 10,298	11	6
(2) Tank-stocking.	42,044	14	0	61,503	13	0	19,458	15	0
Total ...	52,491	10	9	61,651	14	3	9,160	3	6
Grand total ...	1,63,929	11	5	2,35,788	8	10	71,858	13	5

To the charges must be added—

	RS.	A.	P.
(1) Establishment charges	81,612	9	9
(2) Public Works Department charges	4,748	0	0

Thus the gross charges amounted to Rs, 2,50,290-5-2 and, if the season receipts under chank fisheries up to the end of June 1917, as given by Mr. Hornell, be taken into account, the net cost of the department was Rs. 14,501-12-4.

In view of the fact that most of the work done is purely experimental, the financial aspect of the work of the department is satisfactory.

7. *General.*—The Government consider that the report of the Marine Biologist and that on the chank fisheries should in future be combined into a single 'Report on Marine Fisheries.' In view of Mr. Hornell's remarks as to the duration of the chank season beyond 31st March the Government direct that for the purposes of future reports the fisheries year will terminate on 30th June.